QuadStick

A Gamepad for Quadriplegic Gamers

User Manual

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Acknowledgments

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Ken Yankelevitz, owner of Quad Control, for making mouth operated joysticks, and other control devices, for quadriplegics for three decades and who's counseling, advice and experience have guided many aspects of the QuadStick development.

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QuadStick

User Manual

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Introduction

The QuadStick is a mouth operated joystick which emulates a Gamepad, Mouse or Keyboard via USB and Bluetooth connections to a Game Console, PC, Mac, or Android device.

The QuadStick is a sophisticated device built around four simple concepts: Inputs, Outputs, Connections and Commands:

Inputs

The mouthpiece has two or three integral sip/puff sensors, a lip position sensor and push switch, attached to a joystick gimbal. On one or both sides of the joystick mouthpiece are silicone rubber sip/puff sensor tubes. The back of the device has connections for the lip position sensor, and additional external inputs.

The joystick position, sip/puff/lip/push sensors and optional external switches are used to generate Input signals to the QuadStick which are then used to transmit Output commands to the Host device (gamepad, pc, etc) over the USB or Bluetooth connection.

Outputs

The QuadStick emulates Gamepad, Mouse and Keyboard devices and each button, key, joystick or movement these devices can send to a game console or PC become Output commands controlled by the Input sensors. There are also two optically isolated solid state relay outputs.

Connections

The Connection, or manner, in which a given input action outputs a command to the host is configurable by the user and can be instantly changed during the operation of device to provide either a game specific setup or one tailored to the user's ability for movement.

The configuration for the device is modified using either a Google Drive Spreadsheet or a spreadsheet program. The Google Drive Spreadsheet allows users to easily share configurations with other individuals (or with us for tech support), plus copy sections of configurations from a library of samples to build up a custom setup. When a new configuration is ready, it is downloaded into the device over the USB connection from either a computer or a PS3 console. For users without easy internet access, a local spreadsheet program, such as Excel or LibreOffice Calc, can be used for all essential configuration needs.

Commands

Commands are given using a Speech Recognition program, either Dragon Naturally Speaking (DNS) or Windows Speech Recognition (WSR), in conjunction with a collection of free software packages. While not required for using the QuadStick, voice commands facilitate playing games or loading custom profiles by letting the user utter phrases to trigger outputs or functions.

Hardware Features

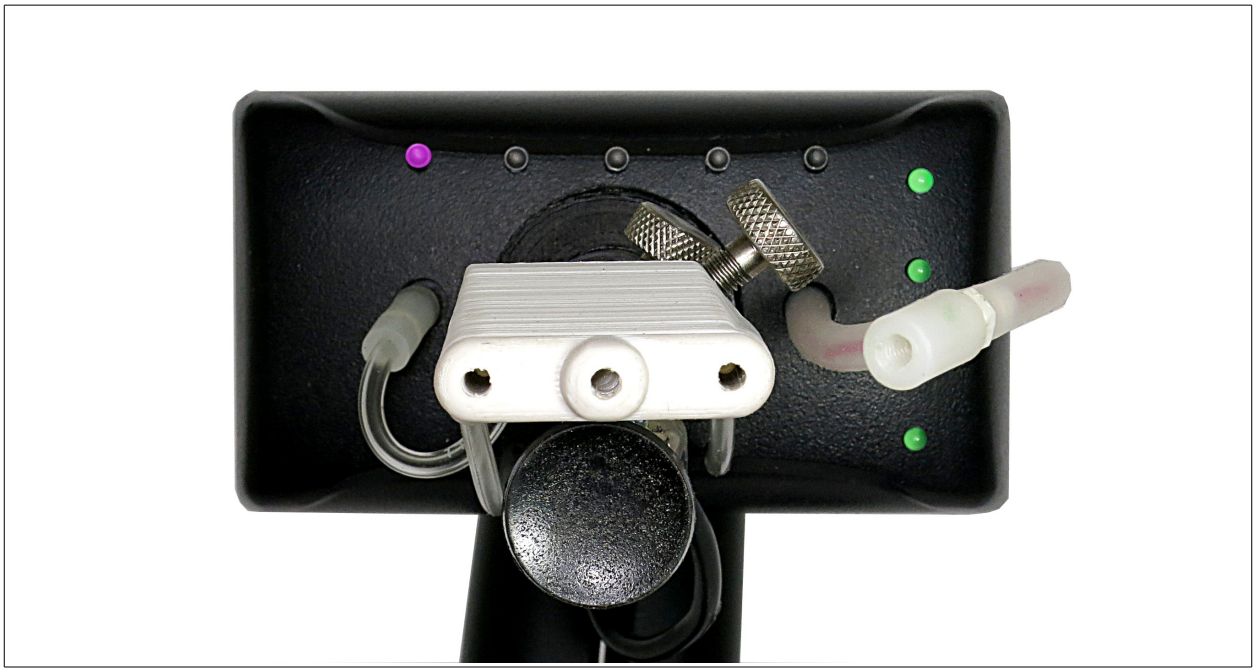


Illustration 1: Front View

Front

1. Mouthpiece attached to Joystick
    - Three Sip/Puff tubes
    - Lip position sensor
    - Push switch
    - XY motion

2. Sip/Puff tube on right side of the joystick

3. Five Blue/Red Status Leds used to indicate:
    - Sensor activation
    - Active configuration profile
    - Boot process and self test
    - USB connection status

4. Four Green Status Leds:
    - External Outputs Status on top pair
    - External Inputs Status on bottom pair

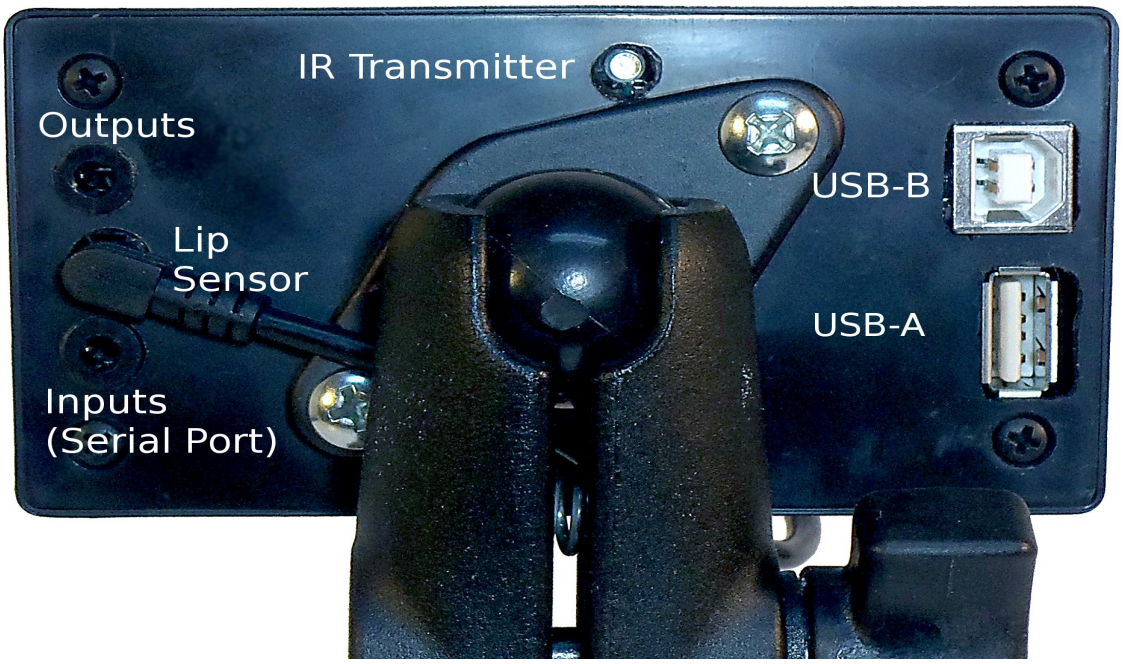


Illustration 2: Rear View

Back Panel

1. USB-B connector for power and/or data connection to Host device

2. USB-A connector
   - For hosting second daisy chained gamepad (not yet implemented)
   - Auxiliary Digital Inputs for 8-way external joystick

3. Output Jack
   - 3mm stereo jack with two optically isolated outputs

4. Input Jack
   - 3mm stereo jack which can connect to two switches or 4-way joystick.
   - TTL-3.3Volt Serial Port
   - Secondary logic level output

5. Infrared Transmitter for A/V equipment remote control

6. Infrared Receiver for learning IR codes (not yet implemented)

7. AMPS mount hole pattern

Sensors and Inputs

Sip/Puff Sensors

The Sip/Puff Sensors on the mouthpiece and the individual tube(s) on either side of the joystick can each sense vacuum or pressure over a range of +/-2kPa (4 inches Water Column) and measure the analog value to categorize the strength as high or low, for a combination of four signals per sensor, hard and soft, sip or puff. When a sensor is active, an LED lights to give feedback to the user. Red for puff and Blue for sip.

To avoid triggering a soft sip/puff signal while applying a stronger pressure, a slight delay (typ 1200ms) is used to allow time for the pressure to move out of the soft region, to the hard region, before generating the signal. While the pressure is in the soft region, the corresponding status LED is lit and an audio tone, which varies with pressure, is produced, to give the user feedback about the pressure they are applying.

Once the time delay has expired, or the pressure increases into the hard range, a click sound indicates the signal has been triggered. Once triggered, the Soft signal latches and the pressure must return below a Deactivation Threshold before the signal will release. When either Soft or Hard pressure signals are active, the pressure above the higher threshold can be used as an analog value, like with a Gamepad Trigger. If the Soft pressure zone for a particular tube is not used, the audio tones are suppressed.

The Mouthpiece

The mouthpiece can have either two or three sip/puff holes plus a lip position sensor. The lip sensor activation and sensitivity is adjustable from a slight movement to one-half inch from the inactive position. A thumbscrew allows the lip sensor to be placed in a comfortable position. The Sip/Puff tube openings in the mouthpiece can be individually selected or used in combination, by positioning the mouth over one, two or three holes or using the tongue to cover one while sipping or puffing on another.

With a three hole, Left, Center, Right, mouthpiece, this allows for six different hole combinations (L, C, R, LC, CR, LCR, LR (by covering the center hole with the tongue)). Multiply that by two pressure polarities (sip/puff), and two different pressure thresholds (soft & hard), for a total of twenty four signals to be obtained from the mouthpiece Sip/Puff sensors: Adding in the Push switch to act as a “Shift” key, doubles that to forty-eight discrete signals (twelve of which can also be analog), before the joystick is even moved.

With the two hole mouthpiece, a total of twelve signals can be obtained from the mouthpiece Sip/Puff sensors: Three tube combinations (L, R, LR) times two polarities of pressure times two strengths of pressure. Adding in the Push switch to act as a “Shift” key, doubles that to twenty-four discrete signals (six of which can also be analog).

In practice, a small subset of the combinations is typically used but the capability is there when needed for special situations.

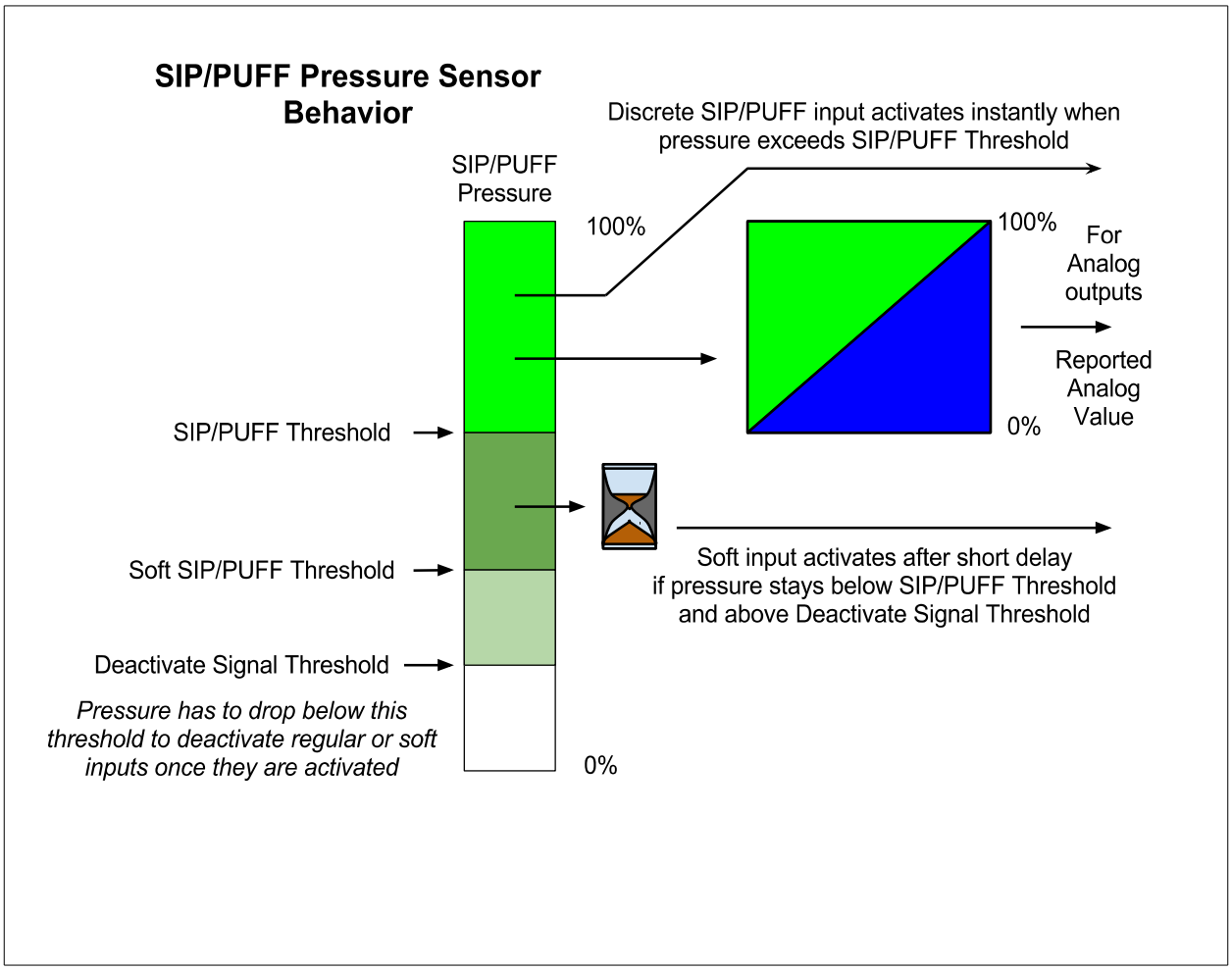

SIP/PUFF Pressure Sensor Behavior
Discrete SIP/PUFF input activates instantly when pressure exceeds SIP/PUFF Threshold
SIP/PUFF Pressure
100%
100%
For Analog outputs
Reported Analog Value
0%
SIP/PUFF Threshold
Soft SIP/PUFF Threshold
Deactivate Signal Threshold
Soft input activates after short delay if pressure stays below SIP/PUFF Threshold and above Deactivate Signal Threshold
Pressure has to drop below this threshold to deactivate regular or soft inputs once they are activated
0%

Illustration 3: Sip/Puff Sensor Behavior

The soft/hard pressure thresholds and the time delay for detecting a soft Sip/Puff are adjustable by the user.

The following table contains the names of all the Sip/Puff inputs for a Three Hole Mouthpiece, with a brief description and if the adjustable delay timer is used to detect the input (This is a factor when determining suitable inputs choices to avoid slowing reaction time during game play):

Input Name	Description	Delay
mp_left_sip	Mouthpiece Hard Sip Left sip/puff sensor	instant
mp_left_puff	Mouthpiece Hard Puff Left sip/puff sensor	instant
mp_center_sip	Mouthpiece Hard Sip Center sip/puff sensor	instant
mp_center_puff	Mouthpiece Hard Puff Center sip/puff sensor	instant
mp_right_sip	Mouthpiece Hard Sip Right sip/puff sensor	instant
mp_right_puff	Mouthpiece Hard Puff Right sip/puff sensor	instant
mp_left_center_sip	Mouthpiece Hard Sip Left-Center sip/puff sensors	instant
mp_left_center_puff	Mouthpiece Hard Puff Left-Center sip/puff sensors	instant
mp_right_center_sip	Mouthpiece Hard Sip Right-Center sip/puff sensors	instant
mp_right_center_puff	Mouthpiece Hard Puff Right-Center sip/puff sensors	instant
mp_left_right_sip	Mouthpiece Hard Sip Left-Right sip/puff sensors	instant
mp_left_right_puff	Mouthpiece Hard Puff Left-Right sip/puff sensors	instant
mp_triple_sip	Mouthpiece Hard Sip All Three sip/puff sensors	instant
mp_triple_puff	Mouthpiece Hard Puff All Three sip/puff sensors	instant
mp_left_sip_soft	Mouthpiece Soft Sip Left sip/puff sensor	delay
mp_left_puff_soft	Mouthpiece Soft Puff Left sip/puff sensor	delay
mp_center_sip_soft	Mouthpiece Soft Sip Center sip/puff sensor	delay
mp_center_puff_soft	Mouthpiece Soft Puff Center sip/puff sensor	delay
mp_right_sip_soft	Mouthpiece Soft Sip Right sip/puff sensor	delay
mp_right_puff_soft	Mouthpiece Soft Puff Right sip/puff sensor	delay
mp_left_center_sip_soft	Mouthpiece Soft Sip Left-Center sip/puff sensors	delay
mp_left_center_puff_soft	Mouthpiece Soft Puff Left-Center sip/puff sensors	delay
mp_right_center_sip_soft	Mouthpiece Soft Sip Right-Center sip/puff sensors	delay
mp_right_center_puff_soft	Mouthpiece Soft Puff Right-Center sip/puff sensors	delay
mp_left_right_sip_soft	Mouthpiece Soft Sip Left-Right sip/puff sensors	delay
mp_left_right_puff_soft	Mouthpiece Soft Puff Left-Right sip/puff sensors	delay
mp_triple_sip_soft	Mouthpiece Soft Sip All Three sip/puff sensors	delay
mp_triple_puff_soft	Mouthpiece Soft Puff All Three sip/puff sensors	delay
right_sip	Hard Sip Right sip/puff sensor	instant
right_puff	Hard Puff Right sip/puff sensor	instant
right_sip_soft	Soft Sip Right sip/puff sensor	delay
right_puff_soft	Soft Puff Right sip/puff sensor	delay

For the two hole mouthpiece, the mp_center_sip/puff is renamed left_sip/puff.

Input Name	Description	Delay
mp_left_sip	Mouthpiece Hard Sip Left sip/puff sensor	instant
mp_left_puff	Mouthpiece Hard Puff Left sip/puff sensor	instant
mp_right_sip	Mouthpiece Hard Sip Right sip/puff sensor	instant
mp_right_puff	Mouthpiece Hard Puff Right sip/puff sensor	instant
mp_left_right_sip	Mouthpiece Hard Sip Both sip/puff sensors	instant
mp_left_right_puff	Mouthpiece Hard Puff Both sip/puff sensors	instant
left_sip	Hard Sip Left sip/puff sensor	instant
left_puff	Hard Puff Left sip/puff sensor	instant
right_sip	Hard Sip Right sip/puff sensor	instant
right_puff	Hard Puff Right sip/puff sensor	instant
mp_left_sip_soft	Mouthpiece Soft Sip Left sip/puff sensor	delay
mp_left_puff_soft	Mouthpiece Soft Puff Left sip/puff sensor	delay
mp_right_sip_soft	Mouthpiece Soft Sip Right sip/puff sensor	delay
mp_right_puff_soft	Mouthpiece Soft Puff Right sip/puff sensor	delay
mp_left_right_sip_soft	Mouthpiece Soft Sip Both sip/puff sensors	delay
mp_left_right_puff_soft	Mouthpiece Soft Puff Both sip/puff sensors	delay
left_sip_soft	Soft Sip Left sip/puff sensor	delay
left_puff_soft	Soft Puff Left sip/puff sensor	delay
right_sip_soft	Soft Sip Right sip/puff sensor	delay
right_puff_soft	Soft Puff Right sip/puff sensor	delay

Table 1: Mouthpiece Inputs for Two Hole Mouthpiece

Joystick

The joystick measures the deflection from the home, or center, position and produces both continuous analog values and discrete position signals, depending upon the output to which it is connected. When used for the Mouse or one of the Game Pad joysticks, the position is reported as continuously variable with the movement of the joystick. When used with a discrete output, like the D-Pad buttons, or to change the TV channel, when sending Infrared commands, the joystick's position is divided up into a series of zones, such as North, South, East and West, which triggers a signal when the joystick is moved into a zone.

The discrete zones are further divided into the Ordinal directions, North-East, South-East, etc as well as into Inner ring and Outer ring zones, in a manner similar to the dual pressure thresholds for the Sip/Puff sensors. When moving through the inner ring, a tone is produced to indicate the joystick is within the inner ring region and a click is produced when either the time delay expires, or the joystick moves into the outer ring and an outer ring signal is triggered.

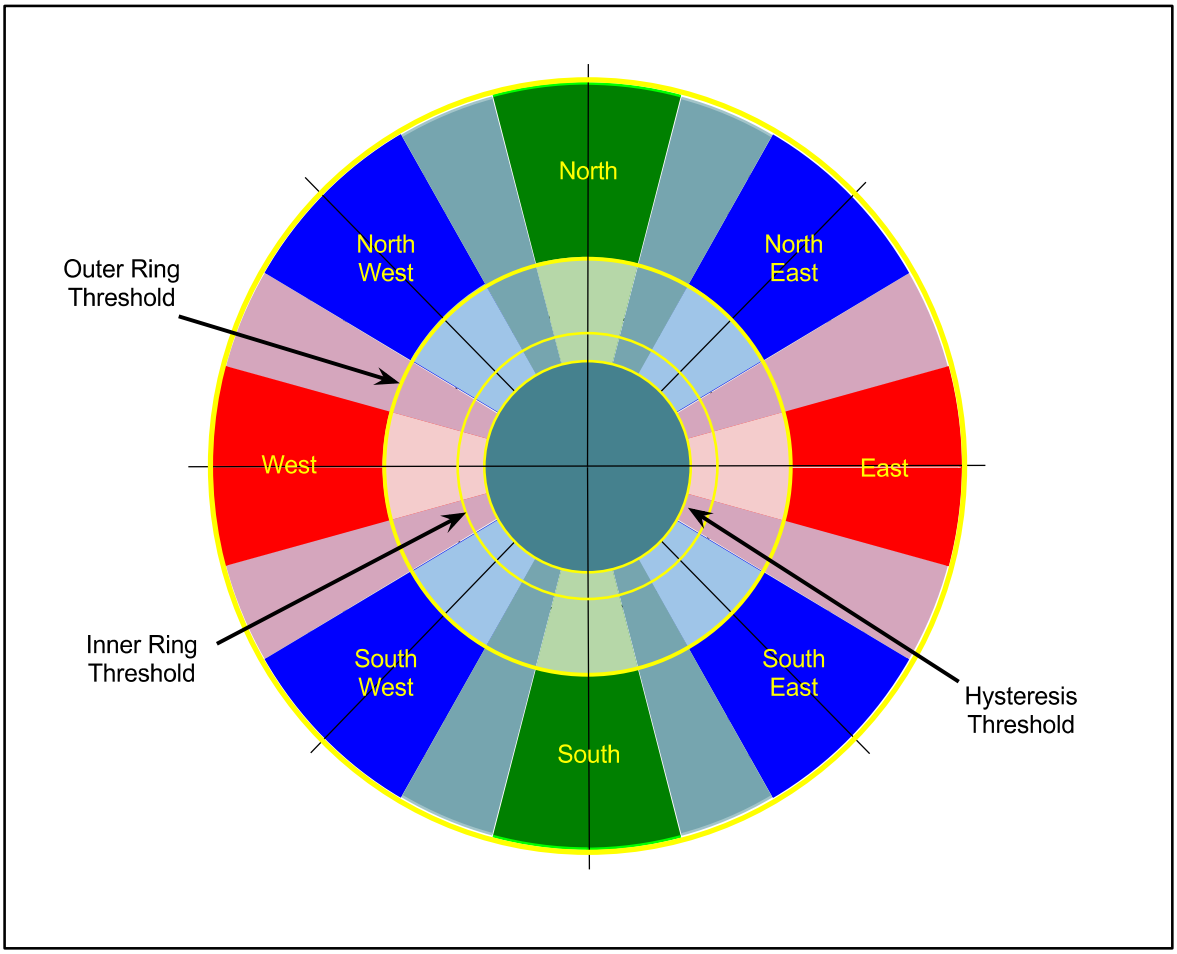


Illustration 4: Joystick Discrete Zones

The Joystick Discrete Zones diagram shows the active areas to which the joystick can be positioned to trigger a signal. The areas of deeper color saturation, around the Cardinal and Ordinal directions, show where the joystick must be to be detected. The lighter mixed color areas between the eight directions show hysteresis areas where the previous signal will remain active until the joystick enters the next detection zone. For instance, starting at North, the joystick can be moved from the Green area, into the Blue-Green-Gray area towards either NE or NW and still maintain the North signal. It can move back into the Green area and no interruption of the North signal will have occurred. However, once the joystick crosses into the Blue area around NE or NW, that new signal becomes active and will remain active as long as the joystick remains in the Blue area or the adjacent Blue-Green or Magenta areas.

The inner and outer rings operate like the Soft and Hard Sip/Puff pressures: After entering the Inner ring, the user must hold the joystick in the area between the Hysteresis ring and the Outer ring until a timer expires and triggers the signal. A tone that varies with the position will sound until the timer expires. Once the Inner ring timer has expired and the inner ring signal is activated, the joystick has to return to the center position before moving to trigger an Outer ring signal. Once triggered, either the inner or outer ring signals will stay active as long as the joystick stays outside the Hysteresis ring. The joystick deflection between the Outer ring and the maximum deflection is scaled into the pressure applied to the corresponding PS3 button, if so mapped.

Sixteen discrete signals can be produced from the joystick using the eight compass directions and the inner/outer rings, plus using the Bite sensor like a Shift key, brings the total to thirty-two.

The deflection ring thresholds and overall sensitivity of the joystick are adjustable by the user. If the inner ring zones are not used in a specific profile, the audio tones are suppressed.

The following table contains the name of all the Joystick Zones input signals, with a brief description and if the adjustable delay timer is used to detect the input.

Input Name	Description	Delay
left	Joystick Left Analog value	instant
right	Joystick Right Analog value	instant
up	Joystick Up Analog value	instant
down	Joystick Down Analog value	instant
N	Joystick Outer ring North zone	instant
NE	Joystick Outer ring North East zone	instant
E	Joystick Outer ring East zone	instant
SE	Joystick Outer ring South East zone	instant
S	Joystick Outer ring South zone	instant
SW	Joystick Outer ring South West zone	instant
W	Joystick Outer ring West zone	instant
NW	Joystick Outer ring North West zone	instant
N_inner	Joystick Inner ring North zone	delay
NE_inner	Joystick Inner ring North East zone	delay
E_inner	Joystick Inner ring East zone	delay
SE_inner	Joystick Inner ring South East zone	delay
S_inner	Joystick Inner ring South zone	delay
SW_inner	Joystick Inner ring South West zone	delay
W_inner	Joystick Inner ring West zone	delay
NW_inner	Joystick Inner ring North West zone	delay

Table 2: Joystick Inputs

Using External Inputs

Up to ten external input switches can be connected to the QuadStick, but there are some subtle issues with how they can be used together. All input signals are “logic level” signals and require switch contacts suitable for low current applications.

Input Jack with Two Switches

The Inputs jack on the back of the QuadStick is a 3mm stereo connector with the two input circuits (Tip & Ring) and Shield (or Ground). Two switches may be connected using the following circuit.

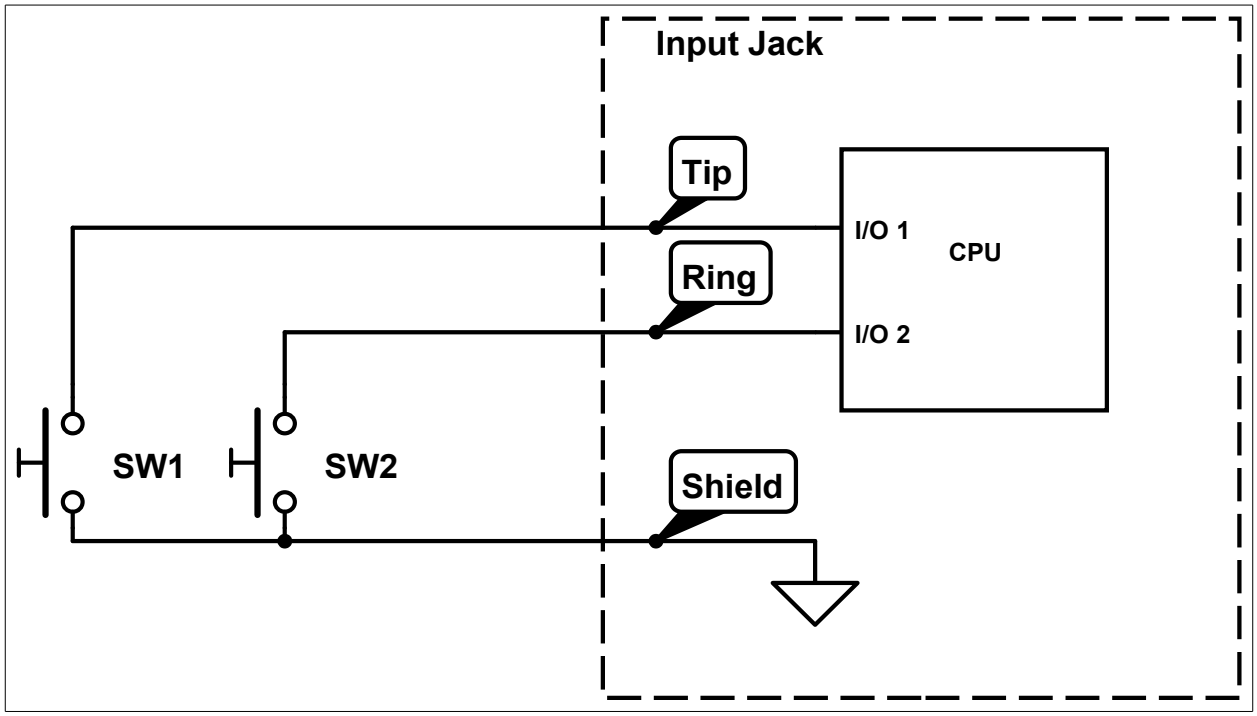


Illustration 5: Digital Input Connections for Two Switches

Input Name	Description	Delay
digital_in_1	Input Jack - Tip to Shield (SW1)	instant
digital_in_2	Input Jack - Ring to Shield (SW2)	instant

Table 3: External Inputs 1 & 2

When using two Switches in this manner, the QuadStick can detect the switch closures independently and simultaneously.

Input Jack with Four Switches

Using the following circuit, it is possible to add two more switches, however, with the caveat that only one switch at a time is allowed to close:

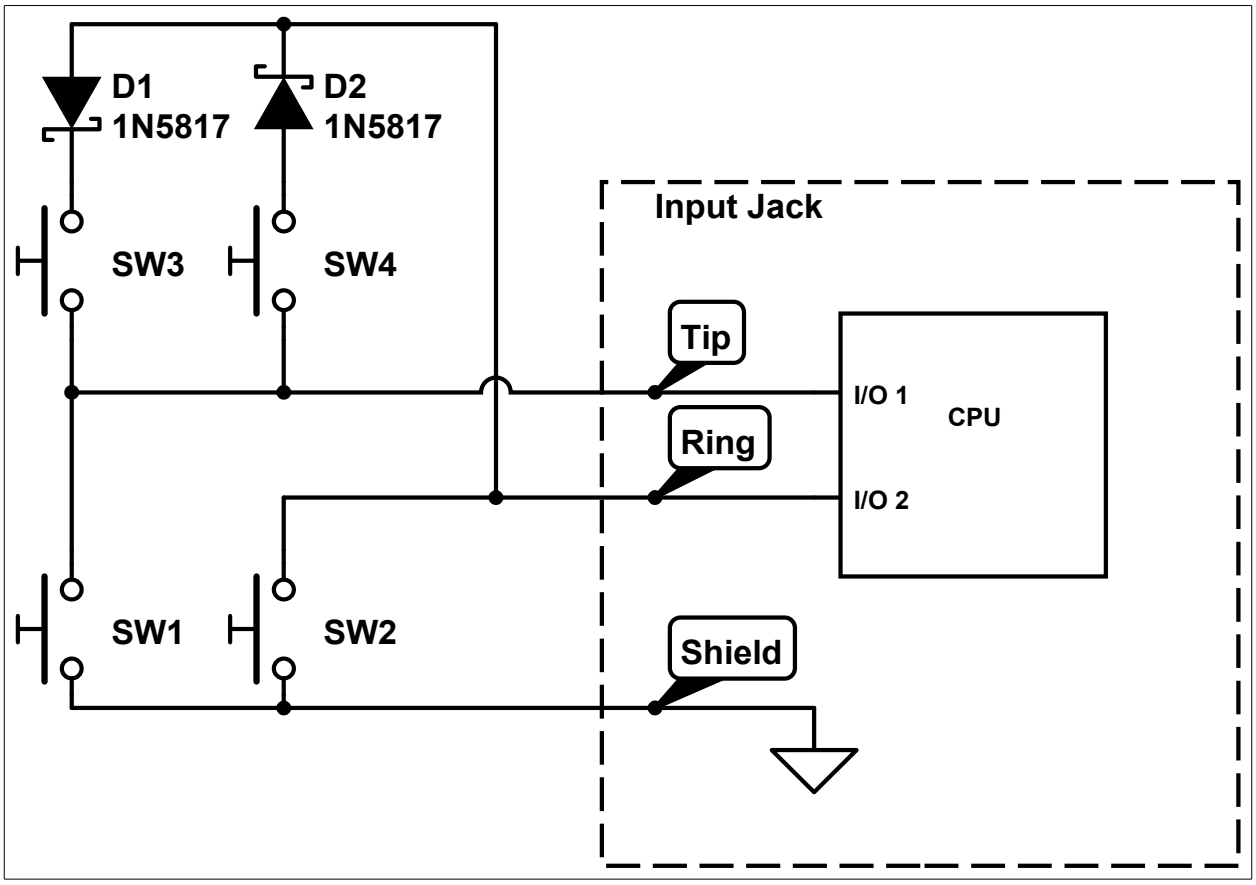


Illustration 6: Digital Input Connections for Four Switches

Input Name	Description	Delay
digital_in_1	Input Jack - Tip to Shield (SW1)	instant
digital_in_2	Input Jack - Ring to Shield (SW2)	instant
digital_in_3	Input Jack - Ring to Diode to Tip (SW3)	instant
digital_in_4	Input Jack - Tip to Diode to Ring (SW4)	instant

Table 4: External Inputs 3 & 4

When Switches 3 and/or 4 (plus the diodes) are added, we can detect which of the four switches are closed, but only if one is closed at a time. We do this by driving each of the I/O pins low, and seeing of the other pin drops low. If two switches are closed simultaneously, we can no longer determine which of the switches are closed, we just know that two, or more, are closed. This configuration is suitable for a 4-way joystick, where only one contact is made at a time or 4 separate switches that would not be operated at the same time.

USB-A Jack with Two Switches

If the USB-A jack is not used for connecting to another USB device, it can be used as another Digital Input channel. Two switches may be connected using the circuit below:

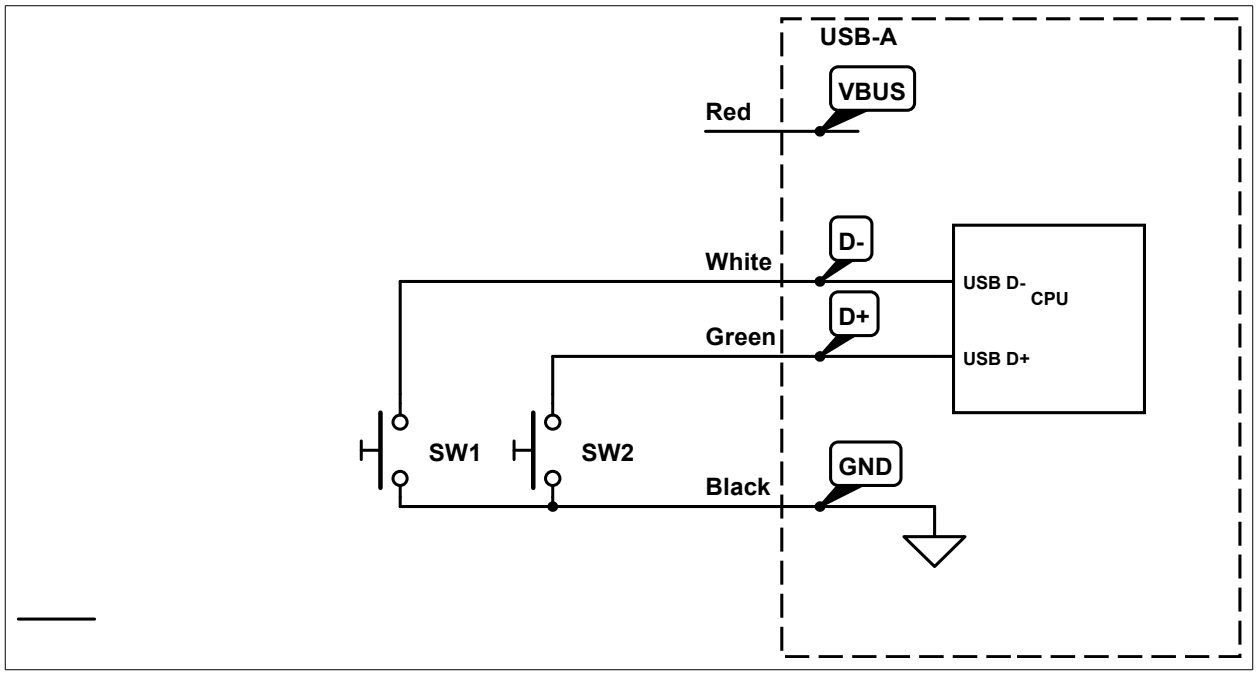


Illustration 7: USB-A Jack with Two Switches

Input Name	Description	Delay
digital_in_5	USB-A Data - to Gnd (SW1)	instant
digital_in_6	USB-A Data + to Gnd (SW2)	instant

Table 5: Digital Inputs 5 & 6

The QuadStick can detect closures of Switches 1 and 2 independently and simultaneously.

USB-A Jack with Four Switches

The next circuit shows how to connect 4 switches to the USB-A connector, with the caveat that Switch pairs 1-3 or 2-4 must never close both switches in a pair at the same time.

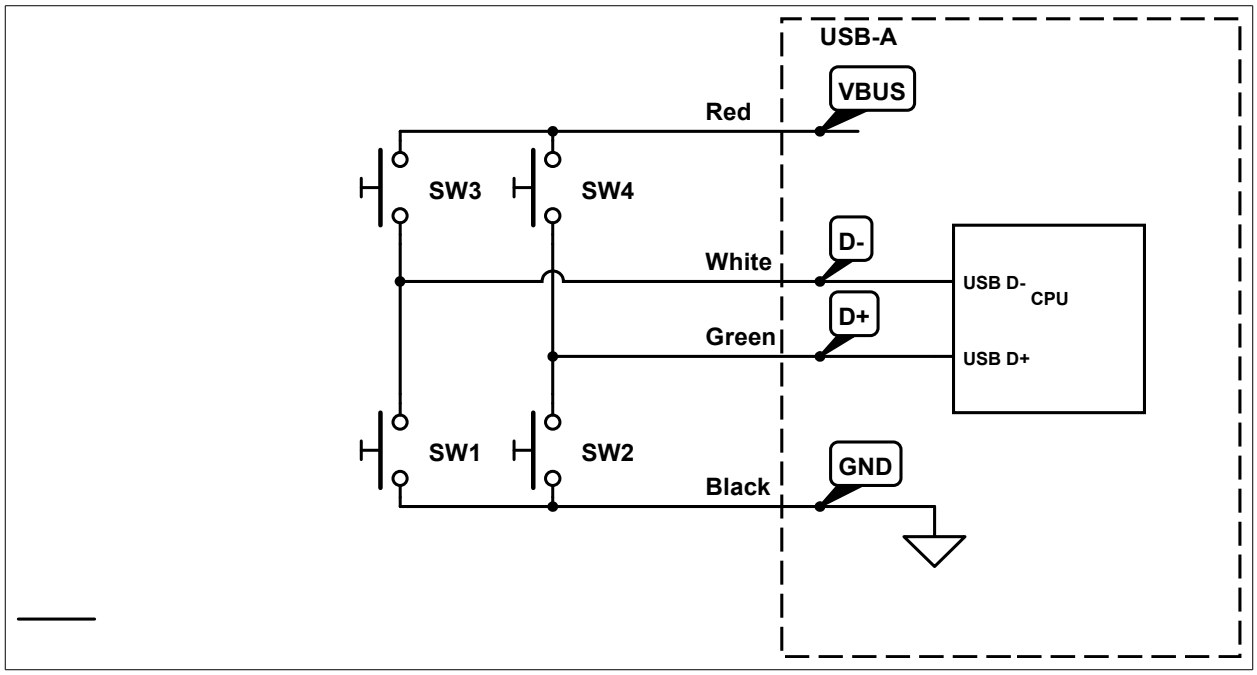


Illustration 8: USB-A Jack with Four Switches

Input Name	Description	Delay
digital_in_5	USB-A Data - to Gnd (SW1)	instant
digital_in_6	USB-A Data + to Gnd (SW2)	instant
digital_in_7	USB-A Data - to Vcc (SW3)	instant
digital_in_8	USB-A Data +to Vcc (SW4)	instant

Table 6: USB-A Digital Inputs 5, 6, 7 & 8

An 8-way joystick is perfect for this circuit, using Switches 1 and 3 for opposite cardinal points (like North and South) and 2 and 4 for the orthogonal cardinal points.

USB-A Jack with Six Switches

There are several caveats to the operation of this port with six switches, like there are the main Digital Input port when using the multiplexed switches. This port can detect Switches 1 and 2, independently and simultaneously, but when we add the additional switches, we have to be careful. As with the circuit with Four switches above, certain combinations of switches must never be allowed to close at the same time, both for the inability to determine which switches are close and the possibility of shorting out the power supply.

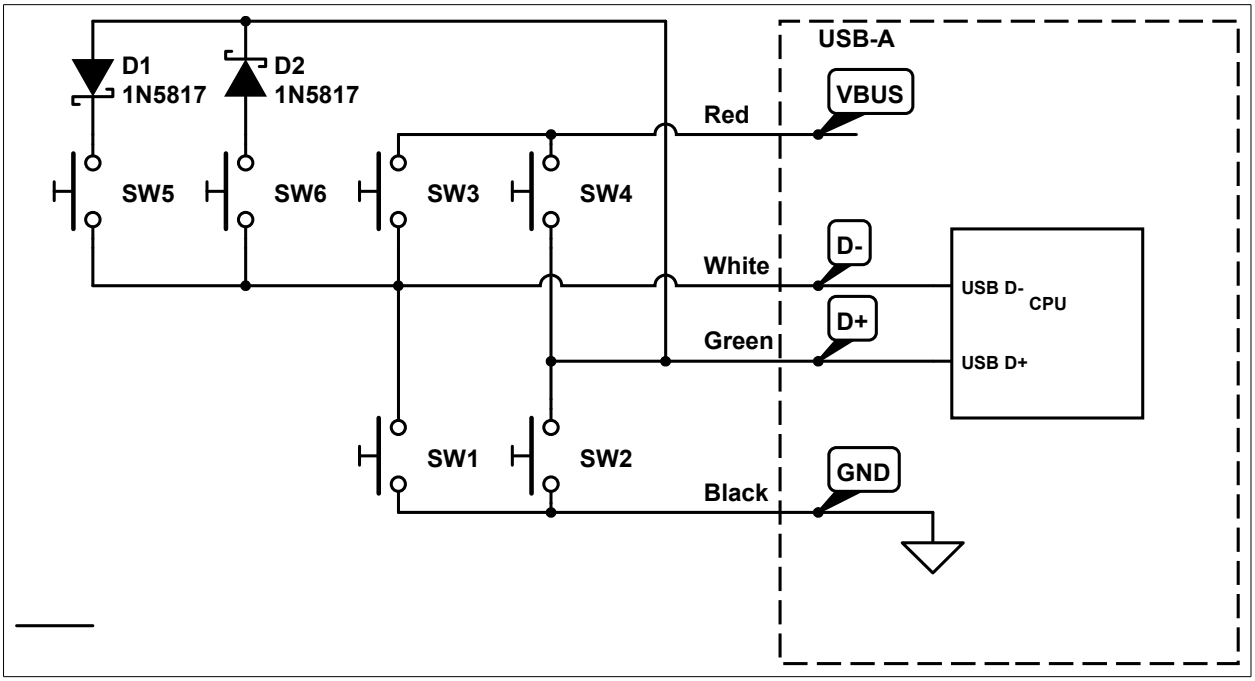


Illustration 9: USB-A Jack with Six Switches

Input Name	Description	Delay
digital_in_5	USB-A Data - to Gnd (SW1)	instant
digital_in_6	USB-A Data + to Gnd (SW2)	instant
digital_in_7	USB-A Data - to Vcc (SW3)	instant
digital_in_8	USB-A Data +to Vcc (SW4)	instant
digital_in_9	USB-A Data + to Diode to Data - (SW5)	instant
digital_in_10	USB-A Data - to Diode to Data + (SW6)	instant

Table 7: USB-A Digital Inputs 5 through 10

USB-A for Chaining 3rd Party Devices

This feature is not yet implemented. The purpose of the USB-A connector is to allow a separate gamepad to be used in tandem to the QuadStick's built-in inputs. If the user can operate some or all inputs of another gamepad, the outputs from that device can be treated as Inputs to the QuadStick and mixed in with the rest of the Input sources in a configuration profile.

Voice Commands

Through a serial connection, either via Bluetooth or the Input jack, commands may be sent to the QuadStick from a PC. The format for activating output signals is:

`output_name,state,value,duration\r`

where:

output_name is from the outputs list.

state is 0=off, 1=on, -1=toggle state.

value is an integer percent 0-100.

duration is in milliseconds or -1 for permanent.

Example, press D-Pad North button with half force for 200 milliseconds:

`dpad_n,1,50,200\r`

Example, press and hold Circle button continuously (until new command or reset):

`circle,1,100,-1`

Plus direct commands for controlling the operation of the QuadStick:

Command	Description
mode,#	Change selected profile mode to new value
reset	Clear all output states and values to zero
boot	Reboot QuadStick
help	Print a Help messong
load,filename.csv	Load new configuration profile
echo	Turn on local echo (for debugging)
swap,output_name	Exchange inputs for Lip Sensor with another output
and,output_name	Add a second output to the Lip Sensor
print	Print out the active profile
debug	Print out internal values

Commands are usually generated by using Dragon Naturally Speaking or Windows Speech Recognition set up with Vocola, a free voice control language program, plus PuTTY, a free communication program, and a Vocola configuration file available from QuadStick's website, to translate spoken words into the proper form for the QuadStick.

Visit the Support page on the QuadStick website for installation instructions and links to the required programs and files.

As of this writing, the following vocabulary has been developed:

Action Buttons			
Square	<nothing>		Pushes button with 100% force for 200 ms
Circle	%		Pushes button with % force for 200 ms
Triangle	% for ## seconds		Pushes button with % force for ## seconds
Xray	For ## seconds		Pushes button with 100% force for ## seconds
Home	On		Holds button down with 100% force
Select	Off		Releases button
Start	Toggle		Releases or Holds button
Left One			
Left Two			
Left Three			
Right One			
Right Two			
Right Three			
D-Pad			
North			D-Pad Up
North East			D-Pad Up and Right
East			D-Pad Right
South East			D-Pad Down and Right
South			D-Pad Down
South West			D-Pad Down and Left
West			D-Pad Left
North West			D-Pad Up and Left

Analog Sticks			
Player	Up	<%>	Holds stick in specified direction by <%>
Look	Down	<%>	(default = 100%)
	Left	<%>	
	Right	<%>	

Lip Sensor Control			
Swap	Square		Switches Lip input with named output
And	Circle		Adds named output to Lip input
	Triangle		
	Xray		
	Home		
	Select		
	Start		
	Clear		Clears out Swap funtion

Quadstick Control			
Reset			All outputs cleared
Quit			
Stop			
Mode ##			Switch directly to mode ##
Full Screen			Toggles Full Screen display
Help			Display help text message
Reboot Quad Stick			Restarts the quadstick
Load	Call of Duty		Loads cod.csv file
	Default		Loads config.csv file

Call of Duty Commands			
Reload			Square
Attack			Circle
Weapon			Triangle
Grenade			R2
Special			L2
Jump			X
Fire			R1 for two seconds
Down			R3
Flat			R3 for 350 ms
Sprint <sec>			L3 for <sec> seconds (default = 20 seconds)
Auto			Square for ten seconds
Aim Rifle			L1 toggle
MLB the Show			
Pick off			L2 for two seconds
	First		L2 for two seconds + Circle
	Second		L2 for two seconds + Triangle
	Third		L2 for two seconds + Square

Summary

The goal of the QuadStick is to be able to extract as much information as possible using just the mouth, lips, and tongue but to also have a way to incorporate external sensors to take advantage of any other inputs the user can actuate.

The number of discrete signals possible in a single configuration profile is thirty-two for the joystick, plus twenty-four for the mouthpiece, plus eight more from each Sip/Puff tubes, for a grand total of seventy-two. Adding any external inputs can, in theory, bring that total up to eighty two. In practice, most applications map a small subset of the possible input signals to outputs, particularly for games, since there are only about twenty buttons on a gamepad. Later, in the Keyboard section, we will see how sequences of multiple input signals can be chained together and used to trigger a specific output.

Emulated Devices

Human Interface Devices

The QuadStick appears on the USB bus to the Host PC or Game Console device as a Composite USB Device that consists of Gamepad, Mouse and Keyboard Devices. These devices are called Human Interface Devices (HID). They each have a specific data report they send to the host over the USB connection. From the perspective of the QuadStick, the data items in these reports are the Outputs to which we connect one of the Inputs from the joystick or Sip/Puff sensors. We call a collection of the Input to Output connections a Profile. The QuadStick configuration can contain several profiles, but only one is active at a time. The active profile can be changed from moment to moment, during a game, to match the mapping of inputs to outputs to the situation in the game. In this section, we will discuss the output data we can send for each device, then, in the section on configuration, how these are tied together with inputs using Profiles.

Flash Drive

The QuadStick also appears on the USB bus as a small removable storage device, a Flash drive. This drive is used to hold the customized configuration file the user may wish to use for a particular game.

Config.csv file

The QuadStick looks for a file with the name “config.csv” in its flash drive and reads the contents at start up or whenever the file changes. The Configuration section describes how this file is created. The user simply copies a new config.csv file into the QuadStick drive to load the new configuration. The config.csv file is produced by the configuration spreadsheet.

Additional configuration .csv files stored in the flash can be loaded using voice commands.

Firmware update

Firmware updates are also copied into the flash drive to reprogram the device. Updates will be posted in the support section of the website. First, save your custom config.csv file, if necessary, then download and copy the new “firmware.bin” file into the QuadStick Flash drive. Wait for it to reprogram the CPU and reboot. The QuadStick will reboot with an empty flash drive and in the default profile. Copy your custom config.sys file back to the flash after the update.

Gamepad

The PS3 Gamepad is designed to be held with both hands, with the thumbs operating two analog joysticks and a set of four buttons on each side. In addition, there are a pair of buttons for the index fingers and another pair of pull triggers for the middle fingers. Three buttons in the middle section are less frequently used during actual game play and serve to control overall operation of the game console. While several of the buttons appear to be simple on/off switches, in comparison to joysticks or triggers which are obviously analog, almost all the buttons measure the pressure too. The X, Circle, Square, Triangle, R1, L1 and the D-Pad buttons all include how hard they are being pressed in the data reported to the console.

The following illustration and Table contain the names of the PS3 outputs used in configuring the QuadStick. We break down compound controls, like the D-Pad or thumbsticks into each their individual elements to allow the greatest flexibility in choosing appropriate inputs to control them.

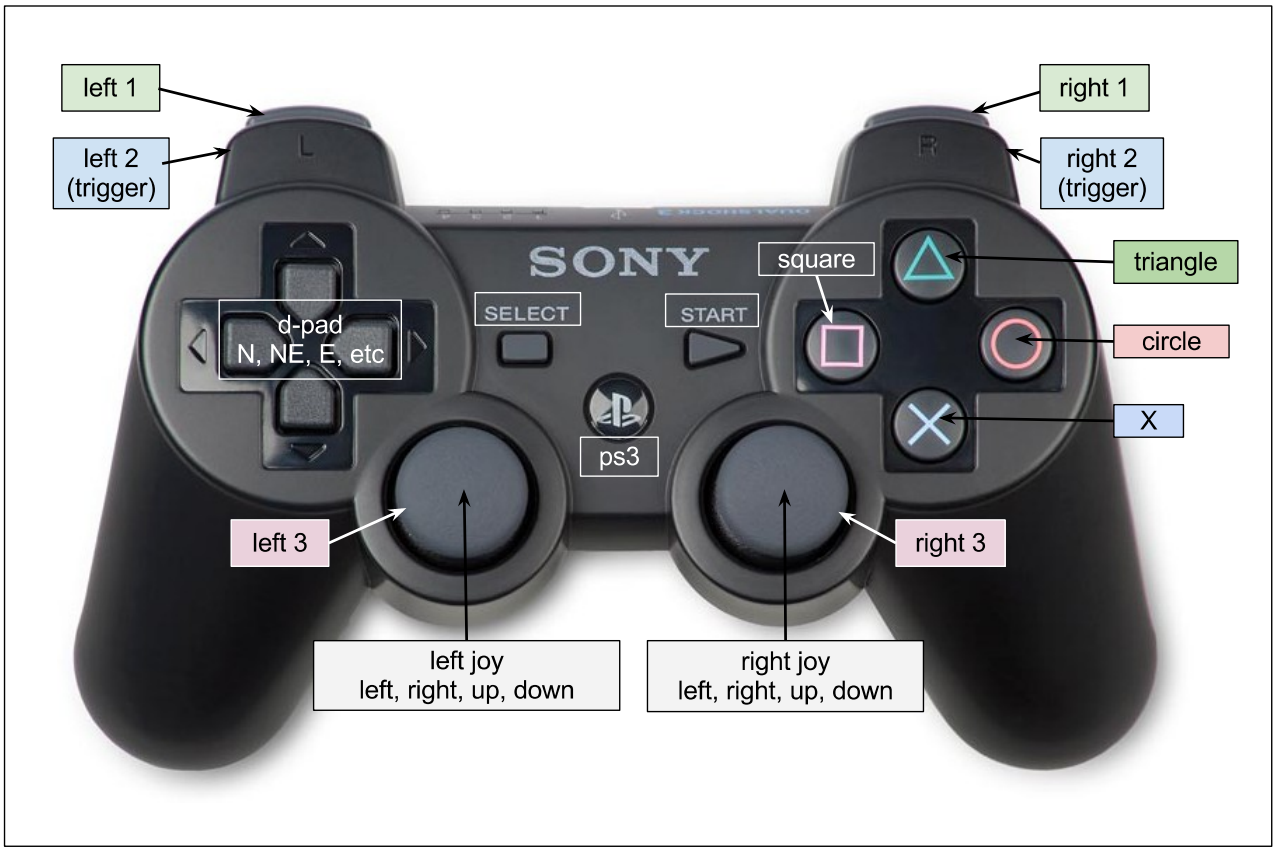


Illustration 10: PS3 Buttons & Controls

Output Name	Description
dpad_N	PS3 D-Pad Button North
dpad_NE	PS3 D-Pad Buttons North and East
dpad_E	PS3 D-Pad Button East
dpad_SE	PS3 D-Pad Buttons South and East
dpad_S	PS3 D-Pad Button South
dpad_SW	PS3 D-Pad Buttons South and West
dpad_W	PS3 D-Pad Button West
dpad_NW	PS3 D-Pad Buttons North and West
left_joy_left	PS3 Left Joystick Left side
left_joy_right	PS3 Left Joystick Right side
left_joy_up	PS3 Left Joystick Up
left_joy_down	PS3 Left Joystick Down
right_joy_left	PS3 Right Joystick Left side
right_joy_right	PS3 Right Joystick Right side
right_joy_up	PS3 Right Joystick Up
right_joy_down	PS3 Right Joystick Down
left_1	PS3 Left Button 1
left_2	PS3 Left Button 2 (trigger)
left_3	PS3 Left Button 3 (Press joystick)
right_1	PS3 Right Button 1
right_2	PS3 Right Button 2 (trigger)
right_3	PS3 Right Button 3 (Press joystick)
x	PS3 Button X
square	PS3 Button Square
triangle	PS3 Button Triangle
circle	PS3 Button Circle
ps3	PS3 Home
select	PS3 Select
start	PS3 Start

Table 8: PS3 Output Commands

Mouse

The Mouse is a simple device compared to the Gamepad but has different movement characteristics that need some explanation: Instead of linearly controlling the position of the screen cursor in direct proportion to the joystick position, for the mouse emulation, the screen cursor is “pushed” around the screen by moving the joystick away from the center position. The farther the joystick is deflected, the faster the cursor moves. Releasing the joystick stops the movement of the cursor and leaves it at its current location. If the mouse operated more like a gamepad joystick, releasing the joystick would return the cursor to the middle of the screen.

The speed at which the cursor moves versus the joystick deflection angle follows a parabolic curve. The speed is calculated from the Square of the deflection from the center position, not in linear proportion to the deflection. This gives the ability for slow and fine control near the center position but also a smooth transition to fast movement with more deflection.

The parameters controlling the mouse speed, maximum joystick deflection and center dead-zone are adjustable by the user.

Illustration 11: Mouse Buttons & Controls

Output Name	Description
mouse_left	Mouse Left movement
mouse_right	Mouse Right movement
mouse_up	Mouse Up movement
mouse_down	Mouse Down movement
mouse_wheel_up	Mouse Wheel Up rotation
mouse_wheel_down	Mouse Wheel Down rotation
mouse_pan_left	Mouse Pan Left tilt
mouse_pan_right	Mouse Pan Right tilt
mouse_back	Mouse Button Back
mouse_forward	Mouse Button Forward
mouse_left_button	Mouse Button Left
mouse_right_button	Mouse Button Right
mouse_middle_button	Mouse Button Middle

Table 9: Mouse Outputs

Keyboard

PC based games often use the keyboard instead of a gamepad. The QuadStick can send any of the key codes for a 104-key keyboard. This opens up the ability to play PC based games by directly sending the desired key-code instead of using gamepad to keyboard adapter software.

Key-codes are associated with the key itself, not necessarily with the character printed on the face of the key. This is more apparent for keys like 2-@, 3-#, etc, than it is for letter keys. (The numeric keypad keys represent 2-down-arrow, 3-page-down, etc.) The Shift, Control or Alt keys, when combined with the key-code, are used to determine how the key is read.

The key-codes are treated like the outputs of the other HID devices. An individual key-code output can be triggered by one of the sensor inputs or by a sequence of inputs in a specific order. The two methods of triggering key-codes are described below.

kb_a	kb_delete	kb_lang6
kb_b	kb_end	kb_lang7
kb_c	kb_page_down	kb_lang8
kb_d	kb_right_arrow	kb_lang9
kb_e	kb_left_arrow	kb_alternate_erase
kb_f	kb_down_arrow	kb_sisreq
kb_g	kb_up_arrow	kb_cancel
kb_h	kb_num_lock	kb_clear
kb_i	kb_keypad_slash	kb_prior
kb_j	kb_keypad_asterisk	kb_return
kb_k	kb_keypad_minus	kb_separator
kb_l	kb_keypad_plus	kb_out
kb_m	kb_keypad_enter	kb_oper
kb_n	kb_keypad_1_and_end	kb_clear_and_again
kb_o	kb_keypad_2_and_down_arrow	kb_crsel_andprops
kb_p	kb_keypad_3_and_page_down	kb_exsel
kb_q	kb_keypad_4_and_left_arrow	kb_keypad_00
kb_r	kb_keypad_5	kb_keypad_000
kb_s	kb_keypad_6_and_right_arrow	kb_thousands_separator
kb_t	kb_keypad_7_and_home	kb_decimal_separator
kb_u	kb_keypad_8_and_up_arrow	kb_currency_unit
kb_v	kb_keypad_9_and_page_up	kb_currency_sub_unit
kb_w	kb_keypad_0_and_insert	kb_keypad_opening_parenthesis
kb_x	kb_keypad_dot_and_delete	kb_keypad_closing_parenthesis
kb_y	kb_non_us_backslash_and_pipe	kb_keypad_opening_brace
kb_z	kb_power	kb_keypad_closing_brace
kb_1_and_exclamation	kb_equal_sign	kb_keypad_tab
kb_2_and_at	kb_f13	kb_keypad_backspace
kb_3_and_hashmark	kb_f14	kb_keypad_a
kb_4_and_dollar	kb_f15	kb_keypad_b
kb_5_and_percentage	kb_f16	kb_keypad_c
kb_6_and_caret	kb_f17	kb_keypad_d
kb_7_and_and_ampersand	kb_f18	kb_keypad_e
kb_8_and_asterisk	kb_f19	kb_keypad_f
kb_9_and_opening_parenthesis	kb_f20	kb_keypad_xor
kb_0_and_closing_parenthesis	kb_f21	kb_keypad_caret
kb_enter	kb_f22	kb_keypad_percentage
kb_escape	kb_f23	kb_keypad_less_than_sign
kb_backspace	kb_f24	kb_keypad_greater_than_sign
kb_tab	kb_execute	kb_keypad_amp
kb_space	kb_help	kb_keypad_amp_amp
kb_minus_and_underscore	kb_manu	kb_keypad_pipe
kb_equal_and_plus	kb_select	kb_keypad_pipe_pipe
kb_opening_bracket_and_opening_brace	kb_stop	kb_keypad_colon
kb_closing_bracket_and_closing_brace	kb_again	kb_keypad_hashmark
kb_backslash_and_pipe	kb_undo	kb_keypad_space
kb_non_us_hashmark_and_tilde	kb_cut	kb_keypad_at
kb_semicolon_and_colon	kb_copy	kb_keypad_exclamation_sign
kb_apostrophe_and_quote	kb_paste	kb_keypad_memory_store
kb_grave_accent_and_tilde	kb_find	kb_keypad_memory_recall
kb_comma_and_less_than_sign	kb_mute	kb_keypad_memory_clear
kb_dot_and_greater_than_sign	kb_volume_up	kb_keypad_memory_add
kb_slash_and_question_mark	kb_volume_down	kb_keypad_memory_subtract
kb_caps_lock	kb_locking_caps_lock	kb_keypad_memory_multiply
kb_f1	kb_locking_num_lock	kb_keypad_memory_divide
kb_f2	kb_lockingroll_lock	kb_keypad_plus_and_minus
kb_f3	kb_keypad_comma	kb_keypad_clear
kb_f4	kb_keypad_equal_sign	kb_keypad_clear_entry
kb_f5	kb_international1	kb_keypad_binary
kb_f6	kb_international2	kb_keypad_octal
kb_f7	kb_international3	kb_keypad_decimal
kb_f8	kb_international4	kb_keypad_hexadecimal
kb_f9	kb_international5	kb_left_control
kb_f10	kb_international6	kb_left_shift
kb_f11	kb_international7	kb_left_alt
kb_f12	kb_international8	kb_left_gui
kb_printscreen	kb_international9	kb_right_control
kb_roll_lock	kb_lang1	kb_right_shift
kb_pause	kb_lang2	kb_right_alt
kb_insert	kb_lang3	kb_right_gui
kb_home	kb_lang4	
kb_page_up	kb_lang5	

Illustration 12: Key-code names

Game play mode

WASD, named for the keys frequently used to move the cursor on a computer screen before the advent of the arrow keys, became popular with many early PC games and continues to be widely used. The QuadStick can be configured to have key-codes mapped directly to inputs, like joystick North to “w”, East to “d”, etc, in the WASD mapping, for rapid, direct response.

It is possible to create configurations which blend mouse, keyboard or even gamepad commands to give the user the best mix for individual games.

See the Tribes Configuration section for an example of a WASD configuration which mixes keyboard and mouse commands.

Illustration 13: Online game "Tribes" keyboard

In the Tribes game, mouthpiece sips and puffs are bound to the WASD keys and the joystick movement is bound to the mouse, which aims the weapon.

Recognition mode

The QuadStick can also recognize a sequence of movements of the joystick (or any sequence of inputs) to trigger an output instead of just a simple single input. This gives the QuadStick the ability to, in-effect, recognize the shapes as letters. A sequence of up to eight input triggers, such as moving the joystick through its discrete zones (as shown in Figure 4), mixed with other inputs, can be strung together to trigger any output.

To use pattern recognition, the user moves the joystick into a zone and momentarily pauses to signal the QuadStick to detect that location. The QuadStick uses the velocity of the joystick dropping to a low value to determine the user's intention and flashes the center Blue LED when it registers that location while recording the pattern. If the user moves through a zone quickly, the QuadStick will not include that zone when matching the pattern, which makes it possible to create patterns that include non-adjacent zones..

Once the pattern matches the sequence of locations in the configuration for an output, the output is triggered. Nearly all patterns start and end at the joystick center position.

The following examples illustrate recognition patterns for the letters A, I and K. The full list of the current default recognition patterns can be found in the chapter on configuration:

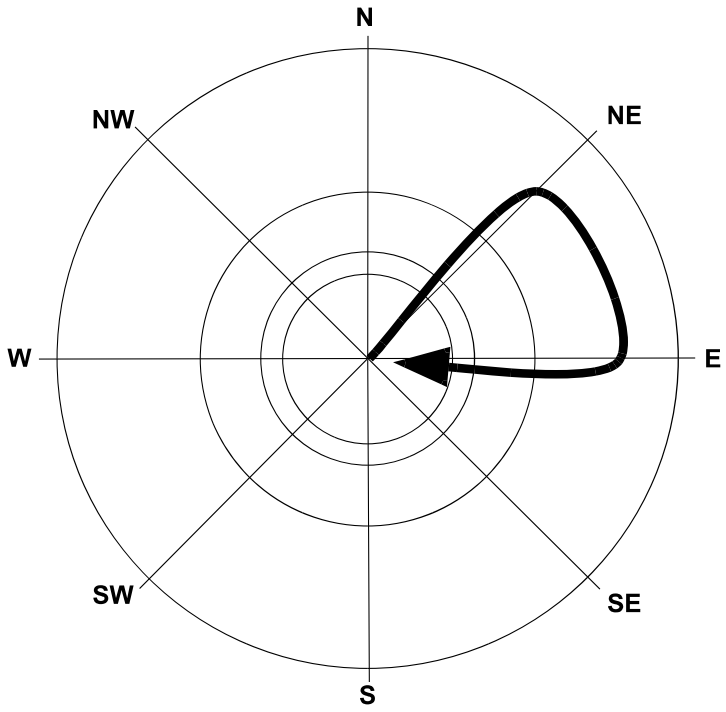


Illustration 14: Pattern for Letter A

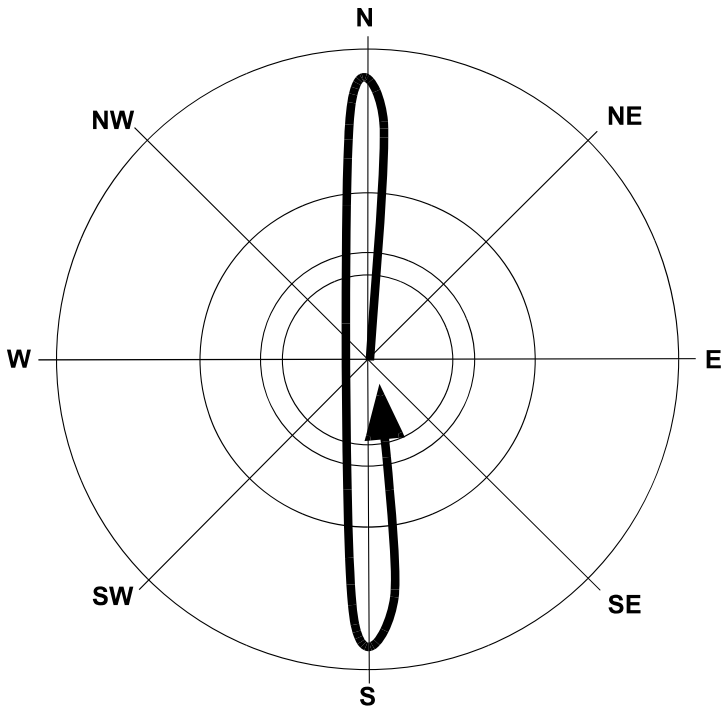


Illustration 15: Pattern for Letter I

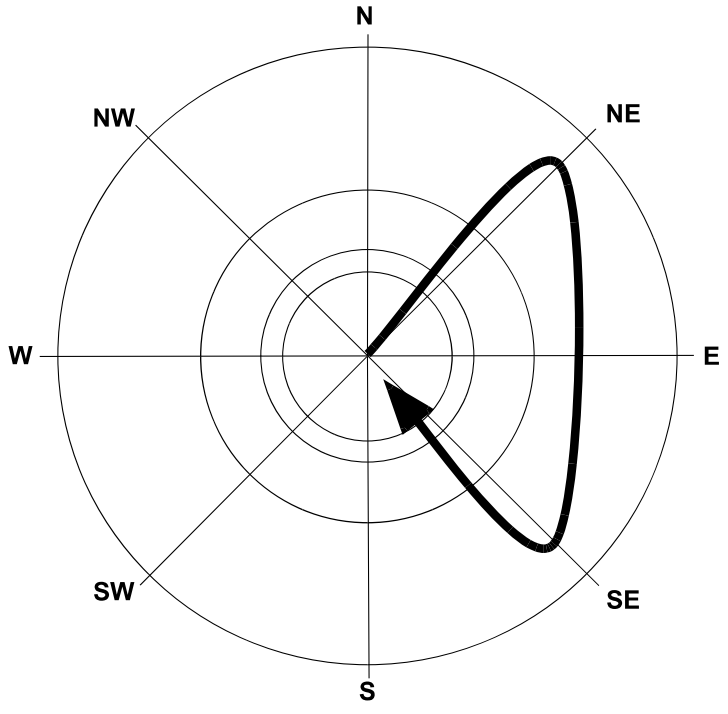


Illustration 16: Pattern for Letter K

Infrared Remote Control

The Infrared transmitter LED on the back panel can be programmed to send IR Remote Control codes. The IR command names are listed below are treated the same as outputs for other kinds of devices in a configuration profile sheet. The specific codes sent for each command are defined on a second sheet, named “IR Codes”, that contains the *Philips Pronto Hex Code* for the particular TV or A/V devices. An example of the Dish VIP-622 receiver is in a later chapter.

Output Name	Description
ir_tv_channel_up	Xmit IR code from command table
ir_tv_channel_down	Xmit IR code from command table
ir_tv_volume_up	Xmit IR code from command table
ir_tv_volume_down	Xmit IR code from command table
ir_tv_on_off	Xmit IR code from command table
ir_tv_select_input	Xmit IR code from command table
ir_play	Xmit IR code from command table
ir_stop	Xmit IR code from command table
ir_fast_forward	Xmit IR code from command table
ir_rewind	Xmit IR code from command table
ir_skip_forward	Xmit IR code from command table
ir_skip_back	Xmit IR code from command table
ir_record	Xmit IR code from command table
ir_pause	Xmit IR code from command table
ir_mute	Xmit IR code from command table
ir_guide	Xmit IR code from command table
ir_menu	Xmit IR code from command table
ir_cancel	Xmit IR code from command table
ir_select	Xmit IR code from command table
ir_up	Xmit IR code from command table
ir_down	Xmit IR code from command table
ir_left	Xmit IR code from command table
ir_right	Xmit IR code from command table
ir_aux1	Xmit IR code from command table
ir_aux2	Xmit IR code from command table
ir_aux3	Xmit IR code from command table
ir_aux4	Xmit IR code from command table

Table 10: Infrared Remote Control command list

Custom Configuration

Configuration is where we take the Inputs and Outputs and connect or bind them together. A collection of input/output connections is called a Profile Mode. The configuration file that is loaded into a QuadStick can contain several modes and the user can chose which one is active at any time. The default method by which profile modes are activated is by sipping and puffing on the Right side tube.

The default configuration for the QuadStick has profile modes for the Mouse, PS3 Left/Right Joysticks and D-Pad. Each of these profiles is presented below.

The user can maintain a library of configuration files customized for individual games or tasks and load them into the QuadStick when desired by copying the associated “config.csv” file into the QuadStick's Flash drive or by using a voice command.

Google Drive Spreadsheet

The primary user interface for manipulating the configuration uses the free Google Drive Spreadsheet cloud service. When a new configuration is ready, the user selects a menu command that converts the spreadsheet into a CSV file and downloads it. Local spreadsheet programs, such as Excel, Open Office or LibreOffice, are supported but do not have some of the features available with Google Spreadsheets for sharing data with other users or displaying the configuration data. The basic ability to change the configuration remains the same for all choices. Once a configuration config.csv file has been prepared, it can be transferred to the QuadStick's Flash drive without the need for an active internet connection.

Each profile within a Configuration spreadsheet file is on a separate “sheet”. The sheets are associated with tabs along the bottom of the page. Profiles are numbered, starting with 1, in the order in which their tabs appear from left to right. The active profile mode number displays on the status LEDs when the profile is changed or when the QuadStick is idle.

As shown on the following pages, the columns and rows in a profile sheet follow a fixed layout. The Outputs are in the leftmost column and each row contains the Inputs that control that output. Each profile mode sheet contains two groups of eight columns each for the Normal and Alternate Input selections. Usually, only the first column of these groups is used for direct Input to Output connections. Later, in a Keyboard configuration, we show how the additional columns are employed for pattern matching.

A sample configuration file is available at: http://demo.quadstick.com/ (in order to see and try the QuadStick menu commands, it is necessary to log in with a Google account and grant permission to run the scripts).

Push Switch Activates Alternate Input Group

The Push Switch is used to select the Alternate Input group. A quick push selects the Alternate group for the next Input activation. A longer push latches the Alternate Input group, like a caps lock key, until a subsequent quick push releases it back to Normal.

In the default Mouse Profile, on the next page, the only thing that changes between the Normal and Alternate Input Groups is the joystick movement controls the cursor in Normal mode and Scrolls the screen in Alternate mode. The left, right, up & down inputs are connected to the mouse_left, _right, _up & _down outputs in Normal mode, and connected to mouse_wheel_up, mouse_wheel_down, mouse_pan_left & mouse_pan_right in the Alternate mode.

The Push Switch input is unique in that it always controls the Normal/Alternate mode selection, whereas all other commands and outputs can be mapped to any input. The Push Switch can be used as a normal input by duplicating the Normal/Alternate input groups and then associating an Output directly with the Push Switch input.

The Push Switch may be too difficult for some players to actuate due limited movement and the relatively high force required, therefore most configuration profiles do not require its use.

PS3 Left Analog mode

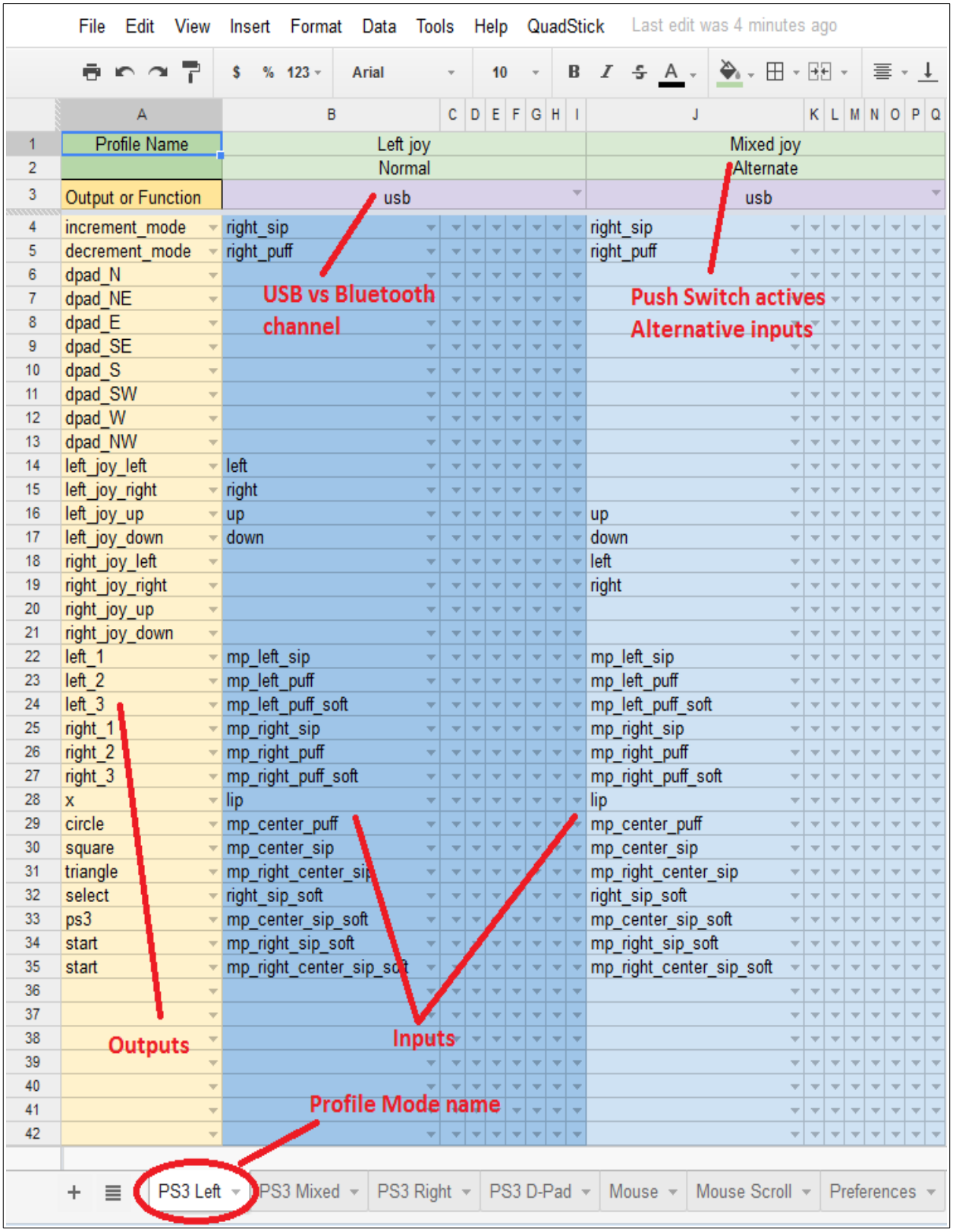


Illustration 17: Default Mouse Profile

Dropdown lists used in Profiles

Dropdown lists of all the Inputs and Outputs that were discussed in previous sections for the sensors and emulated devices are used to guide the user when creating a new profile.

To chose an Output command or Input source, click in the desired cell and an arrow symbol will display near the upper right corner. Clicking on this symbol will display the list of available Outputs. (It can take a while for the list to appear the first time, so give it time). A profile is created by adding additional Output choices and matching that up with an Input. A blank cell in the Outputs column indicates the end of the list, any outputs following an empty cell will be ignored. A blank cell in an Inputs column means the Output is not used in that mode.

It is permitted to have more than one Input associated with an Output, just repeat the Output choice on another row and select the additional Input to trigger it. It is also possible to have a single Input trigger more than one Output by just selecting the same Input again for the additional Outputs. This primarily is used for building up Control, Alt, or Shifted keycodes, where a single Input will trigger a combination of outputs to send the desired key, or where more than one Input is triggering Shifted keycodes.

USB/Bluetooth connections

The communication channel for a profile can be selected from another dropdown list that contains USB and Bluetooth choices for each input group. The QuadStick can have a USB connection to one device while having a simultaneous Bluetooth connection to another. When the profile becomes active, the chosen connection receives the command stream.

When using Voice commands, the Bluetooth device is used as a serial connection between the PC running voice recognition software and the QuadStick which is connected to the PS3 via USB and is not available as a profile communication channel.

Dropdown list for Outputs

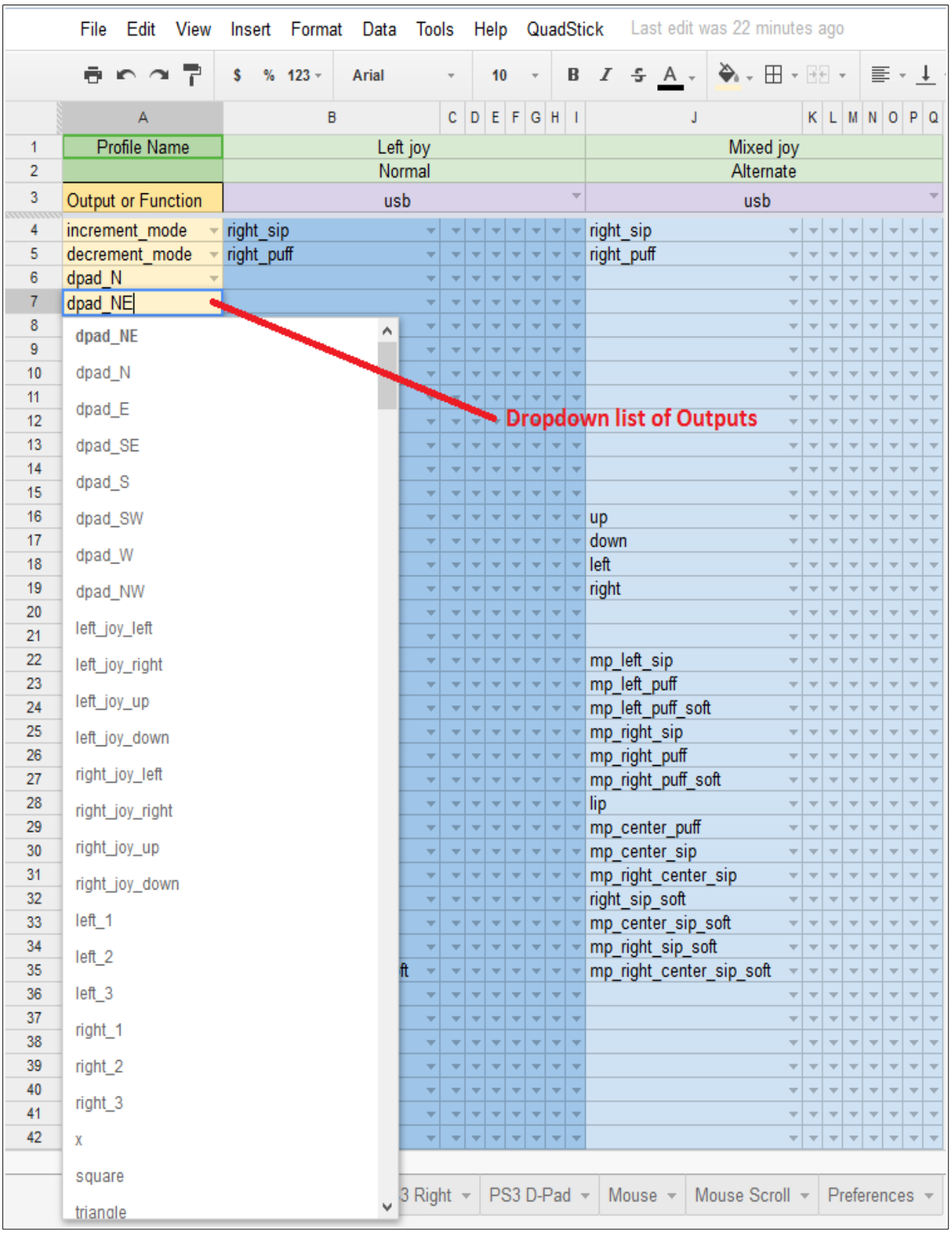


Illustration 18: Output Commands Dropdown List

Dropdown list for Inputs

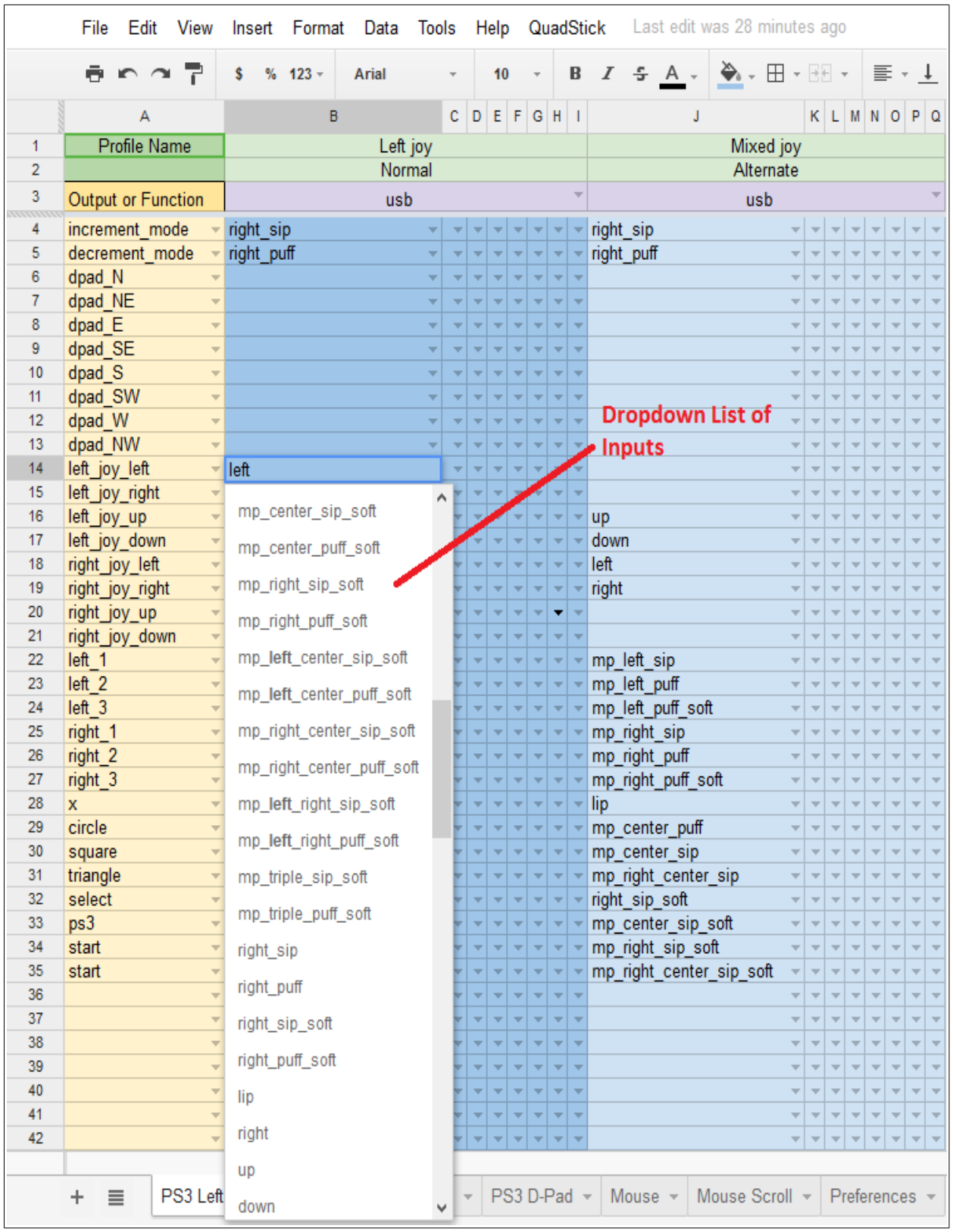


Illustration 19: Input Sensor Dropdown List

QuadStick Menu

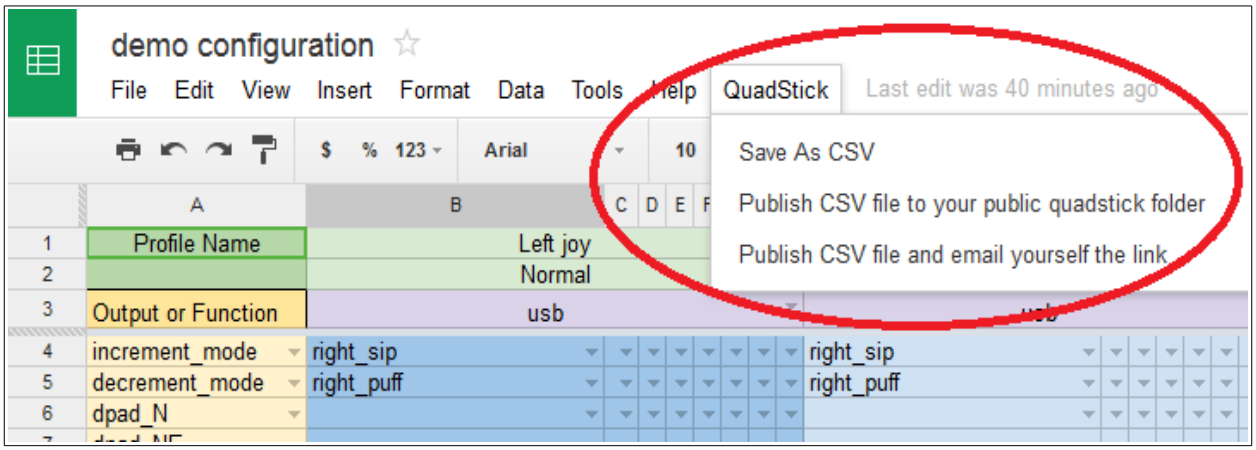


Illustration 20: QuadStick Spreadsheet Menu Commands

The Menu bar for the configuration spreadsheet has three commands added to download and display the configuration file. The Save As CSV command will convert the spreadsheet into a “config.csv” file and download it to the user's computer. Copy the new file into the QuadStick's flash drive to load the new configuration settings.

PS3 web browsers do not work properly with Google Drive at this time, so the “Save As CSV” command is not available via the PS3. As a workaround, the “Publish CSV file to your public quadstick folder” command places a copy of the config.csv in a location that will be available via a PS3 web browser.

This workaround is to make it easy to put new configurations into a QuadStick connected to a PS3 or other game console that does not have a Google Drive compatible browser

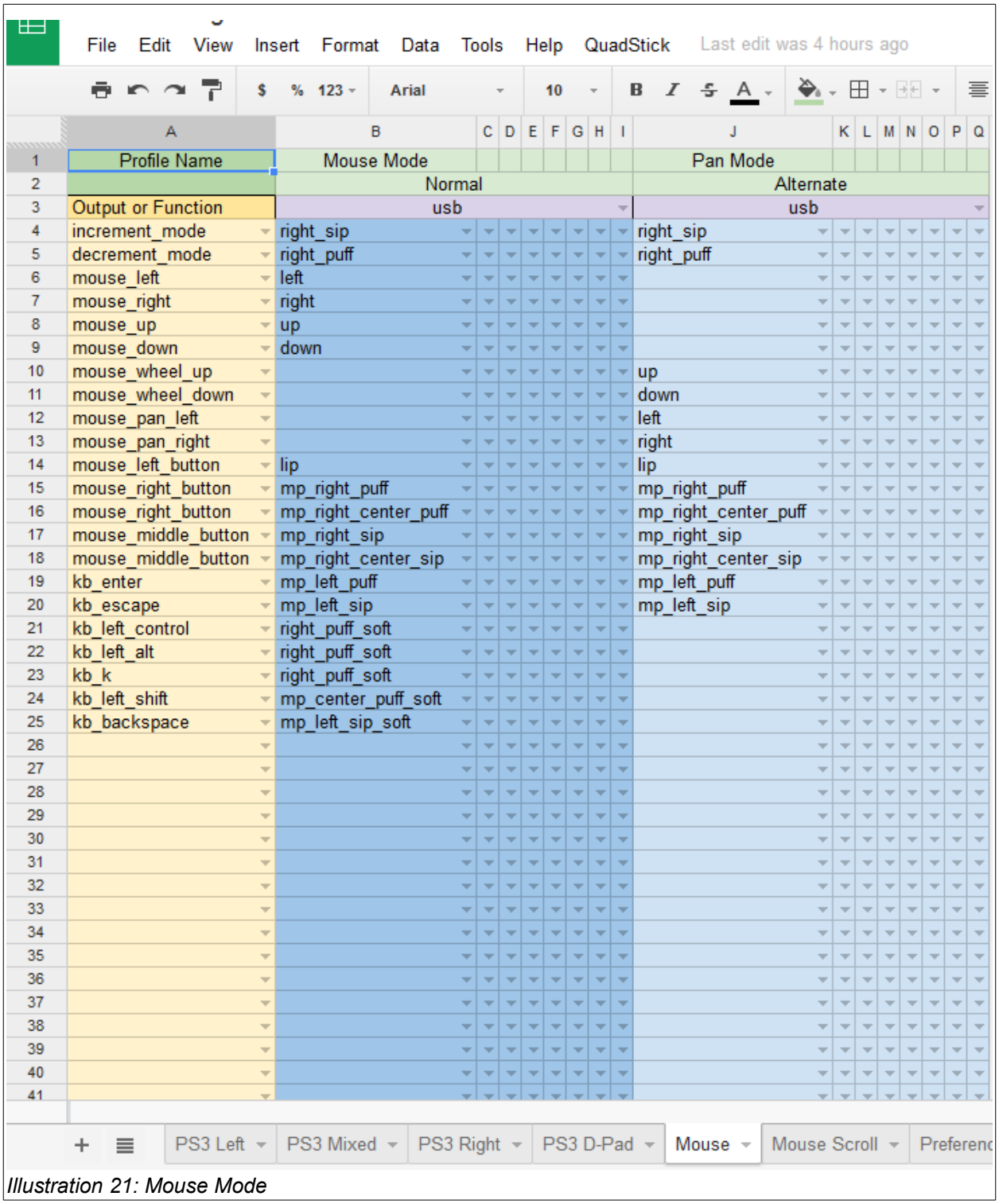
After using the “Publish CSV file and email...” command:

- Find the folder named "Public" in the "My Drive" of your Google Drive
- Check the selection box next to the Public folder
- Pull down the More menu
- Select Share...
- Find "Who has access", then click "change" to modify the private setting to "Public on the Web", then Save, then Done
- The link in the email should now be active
- The short url can be opened from a PS3 webserver to download new config.csv files to a QuadStick
- Simply Trash the Public folder at any time to deactivate it. A new one can be created at any time

Use the short URL link to enter the address into the PS3 browser and save the page bookmark for future downloads.

The following Mouse and Mouse Scroll modes are primarily used with a PC.

Mouse Mode



	A	B	J
1	Profile Name	Mouse Mode	Pan Mode
2		Normal	Alternate
3	Output or Function	usb	usb
4	increment_mode	right_sip	right_sip
5	decrement_mode	right_puff	right_puff
6	mouse_left	left	
7	mouse_right	right	
8	mouse_up	up	
9	mouse_down	down	
10	mouse_wheel_up		up
11	mouse_wheel_down		down
12	mouse_pan_left		left
13	mouse_pan_right		right
14	mouse_left_button	lip	lip
15	mouse_right_button	mp_right_puff	mp_right_puff
16	mouse_right_button	mp_right_center_puff	mp_right_center_puff
17	mouse_middle_button	mp_right_sip	mp_right_sip
18	mouse_middle_button	mp_right_center_sip	mp_right_center_sip
19	kb_enter	mp_left_puff	mp_left_puff
20	kb_escape	mp_left_sip	mp_left_sip
21	kb_left_control	right_puff_soft	
22	kb_left_alt	right_puff_soft	
23	kb_k	right_puff_soft	
24	kb_left_shift	mp_center_puff_soft	
25	kb_backspace	mp_left_sip_soft	

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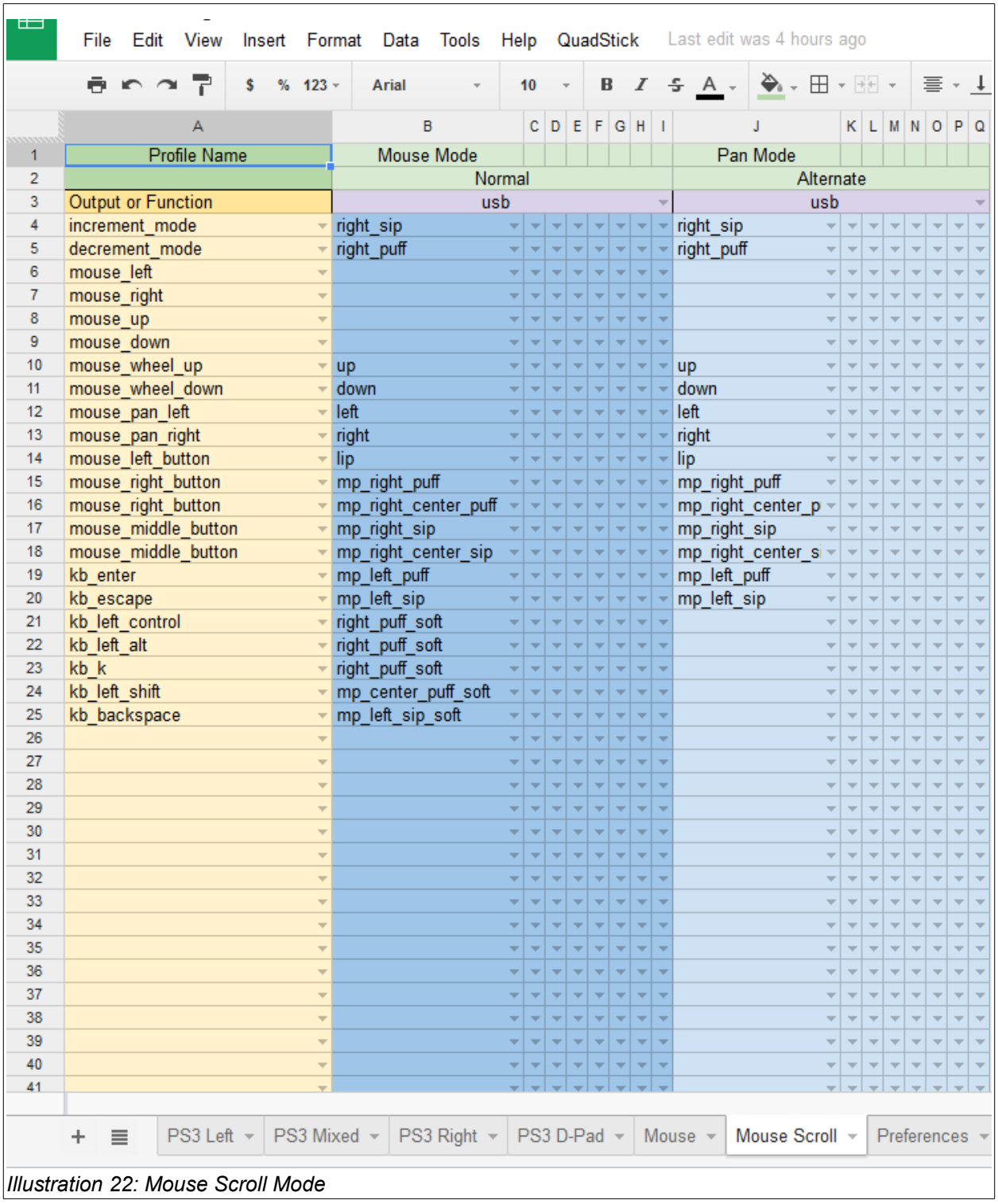
PS3 Left PS3 Mixed PS3 Right PS3 D-Pad Mouse Mouse Scroll

Illustration 21: Mouse Mode

Mouse Scroll Mode



	A	B	J
1	Profile Name	Mouse Mode	Pan Mode
2		Normal	Alternate
3	Output or Function	usb	usb
4	increment_mode	right_sip	right_sip
5	decrement_mode	right_puff	right_puff
6	mouse_left		
7	mouse_right		
8	mouse_up		
9	mouse_down		
10	mouse_wheel_up	up	up
11	mouse_wheel_down	down	down
12	mouse_pan_left	left	left
13	mouse_pan_right	right	right
14	mouse_left_button	lip	lip
15	mouse_right_button	mp_right_puff	mp_right_puff
16	mouse_right_button	mp_right_center_puff	mp_right_center_p
17	mouse_middle_button	mp_right_sip	mp_right_sip
18	mouse_middle_button	mp_right_center_sip	mp_right_center_s
19	kb_enter	mp_left_puff	mp_left_puff
20	kb_escape	mp_left_sip	mp_left_sip
21	kb_left_control	right_puff_soft	
22	kb_left_alt	right_puff_soft	
23	kb_k	right_puff_soft	
24	kb_left_shift	mp_center_puff_soft	
25	kb_backspace	mp_left_sip_soft	

Illustration 22: Mouse Scroll Mode

Keyboard Profile

The Keyboard Profile shows the use of pattern recognition in triggering outputs. Starting in the center, the joystick is moved to one or more zones and when the pattern matches one in the profile, the output is triggered and the QuadStick is ready to start matching the next pattern.

Zones are recognized by a momentarily pausing inside a zone before moving to the next location. The center Blue LED will flash at the moment the pause is detected to aid the user in getting a feel for the timing.

Pattern matching rules:

There are some rules to observe when creating a pattern:

- When a pattern matches, the output is triggered. This means that a pattern like a simple N (north) cannot be mixed in with any longer patterns that begin with N because the shorter pattern would match first, trigger its output and clear the match buffer. N, Center, however, would work, since the next location after N would not be Center for the longer pattern.
- Inputs besides joystick zones can be part of a pattern. A Sip/Puff input can be used in the sequence, with the understanding that whatever position the joystick is in will be immediately added to the pattern buffer after the Sip/Puff input deactivates. For instance, starting with the joystick in the Center, a Left Sip could be the first input in a sequence that went like: Left Sip, Center, N, Center. Another example could be to place a Sip/Puff input in the middle of a sequence: N, mp_both_sip, N, Center could be used.
- Leaving the joystick in the Center position for more than a second will flush the pattern buffer, if the user needs to restart a pattern due to a mistake.
- Inner joystick zones can be used in a pattern but the joystick will need to return to the center to release the inner zone latch. This means inner joystick zones work best at the end of a sequence.

Keyboard letter matching is not the only use for pattern recognition. Since it multiplies the number of signals the device can distinguish by adding a time/sequence element, it may be useful for individuals with very limited head and neck movement to substitute for other inputs.

Default Keyboard Profile

default config

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Comments Share

Arial 10

Profile Name

	A	B	C	D	E	F	G	J	K	L
1	Profile Name	Keyboard Mode						Keyboard Shift Mode		
2		Normal						Alternate		
3	Output or Function	usb						usb		
4	increment_mode	push								
5	decrement_mode							push		
6	kb_enter	mp_both_sip						mp_both_sip		
7	kb_backspace	mp_both_puff						mp_both_puff		
8	kb_escape	left_sip						left_sip		
9	kb_home									
10	kb_insert									
11	kb_delete	mp_both_puff_soft						mp_both_puff_soft		
12	kb_left_control	S_inner						S_inner		
13	kb_left_alt	W_inner						W_inner		
14	kb_left_gui	left_sip_soft						left_sip_soft		
15	kb_left_shift	N_inner						N_inner		
16	kb_tab	E_inner						E_inner		
17	kb_up_arrow	N	center							
18	kb_down_arrow	S	center							
19	kb_left_arrow	W	center							
20	kb_right_arrow	E	center							
21	kb_page_down	SE	center							
22	kb_page_up	NE	center							
23	kb_a	NE	E	center						
24	kb_b	E	S	center						
25	kb_c	W	SW	S	center					
26	kb_d	W	S	center						
27	kb_e	NW	center							
28	kb_f	N	NW	SW	center					
29	kb_g	W	NW	N	S	SW	center			
30	kb_h	N	S	E	SE	center				
31	kb_i	N	S	center						
32	kb_j	S	SW	center						
33	kb_k	NE	SE	center						
34	kb_l	S	SE	center						
35	kb_m	SW	W	S	E	SE	center			
36	kb_n	S	E	SE	center					
37	kb_o	W	SW	SE	E	center				
38	kb_p	N	NE	E	center					
39	kb_q	N	NW	W	SE	center				
40	kb_r	N	NE	center						
41	kb_s	N	W	E	S	center				
42	kb_t	N	NW	N	center					
43	kb_u	S	SE	E	center					
44	kb_v	S	E	center						
45	kb_w	W	SW	center						
46	kb_x	NE	SW	NW	SE	center				
47	kb_y	SE	E	S	center					
48	kb_z	E	S	SE	center					
49	kb_1_and_exclamation							N	center	
50	kb_2_and_at							NE	center	
51	kb_3_and_hashmark							E	center	
52	kb_4_and_dollar							SE	center	
53	kb_5_and_percentage							SE	S	center
54	kb_6_and_caret							S	center	
55	kb_7_and_and_ampersand							SW	S	center
56	kb_8_and_asterisk							SW		
57	kb_9_and_opening_parenthesis							W	center	
58	kb_0_and_closing_parenthesis							NW	center	
59										

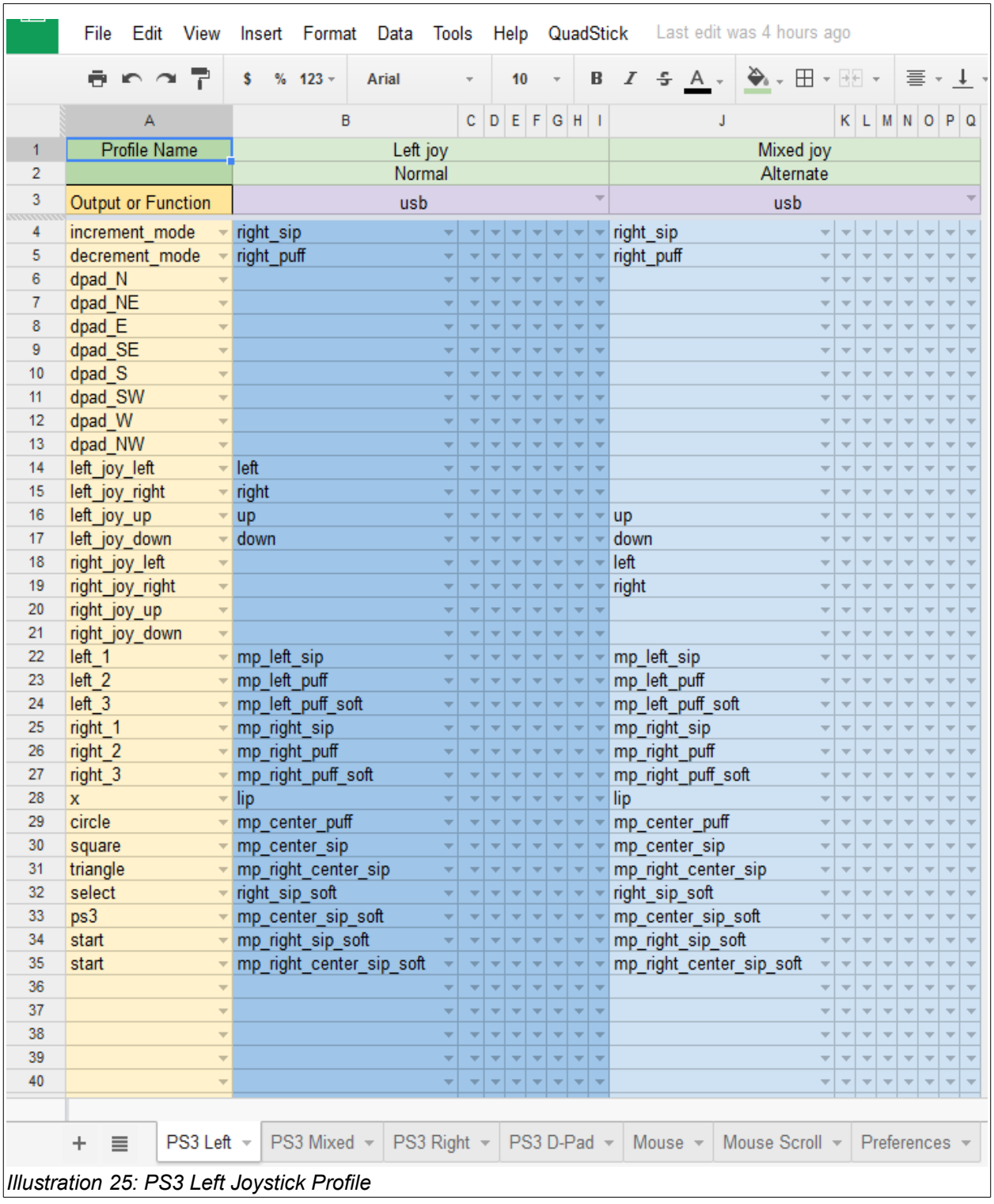
Mouse | Keyboard | PS3 Right | PS3 Left | PS3 D-Pad | System | Preferences

Illustration 23: Keyboard Pattern Profile

Illustration 24: Default Keyboard Profile Letter Patterns

The four default PS3 profiles all share the same Outputs list. For the Left, Mixed, Right and D-Pad Joysticks, the Alternate input groups mix in the other joystick's left-right movement while leaving the up-down movement connected to the original joystick.

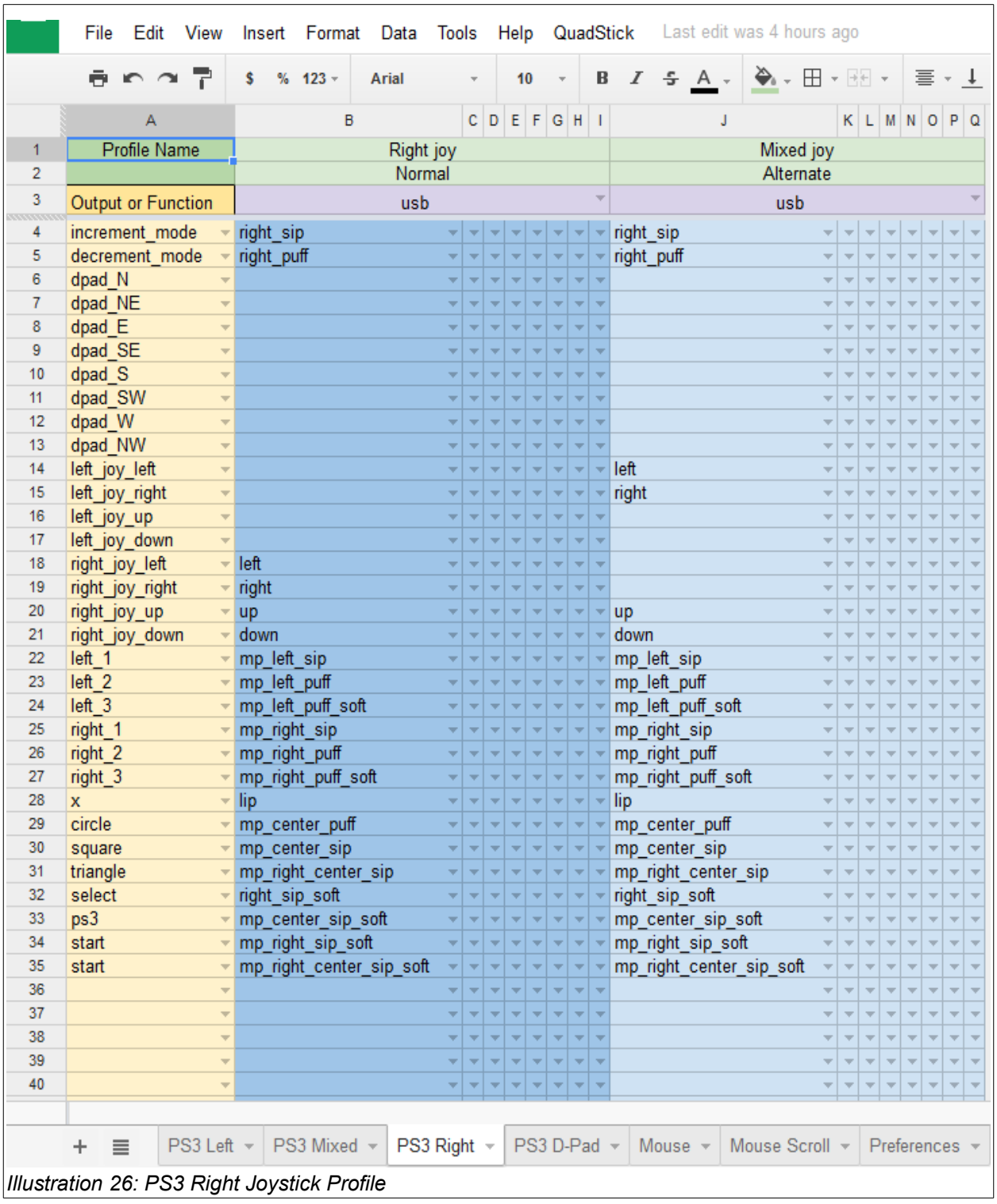
PS3 Left Joystick Profile



	A	B	J
1	Profile Name	Left joy	Mixed joy
2		Normal	Alternate
3	Output or Function	usb	usb
4	increment_mode	right_sip	right_sip
5	decrement_mode	right_puff	right_puff
6	dpad_N		
7	dpad_NE		
8	dpad_E		
9	dpad_SE		
10	dpad_S		
11	dpad_SW		
12	dpad_W		
13	dpad_NW		
14	left_joy_left	left	
15	left_joy_right	right	
16	left_joy_up	up	up
17	left_joy_down	down	down
18	right_joy_left		left
19	right_joy_right		right
20	right_joy_up		
21	right_joy_down		
22	left_1	mp_left_sip	mp_left_sip
23	left_2	mp_left_puff	mp_left_puff
24	left_3	mp_left_puff_soft	mp_left_puff_soft
25	right_1	mp_right_sip	mp_right_sip
26	right_2	mp_right_puff	mp_right_puff
27	right_3	mp_right_puff_soft	mp_right_puff_soft
28	x	lip	lip
29	circle	mp_center_puff	mp_center_puff
30	square	mp_center_sip	mp_center_sip
31	triangle	mp_right_center_sip	mp_right_center_sip
32	select	right_sip_soft	right_sip_soft
33	ps3	mp_center_sip_soft	mp_center_sip_soft
34	start	mp_right_sip_soft	mp_right_sip_soft
35	start	mp_right_center_sip_soft	mp_right_center_sip_soft
36			
37			
38			
39			
40			

Illustration 25: PS3 Left Joystick Profile

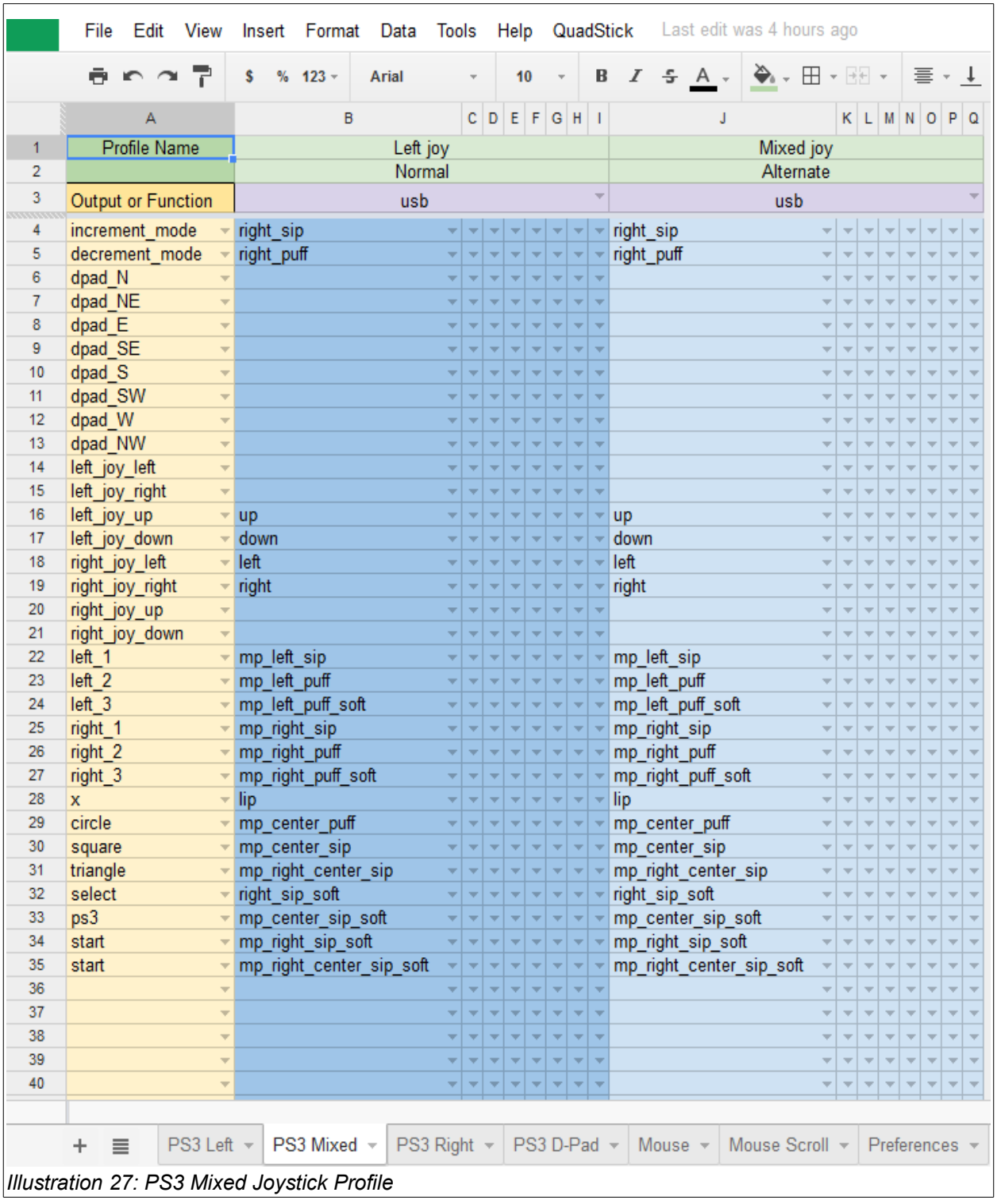
PS3 Right Joystick Profile



	A	B	J
1	Profile Name	Right joy	Mixed joy
2		Normal	Alternate
3	Output or Function	usb	usb
4	increment_mode	right_sip	right_sip
5	decrement_mode	right_puff	right_puff
6	dpad_N		
7	dpad_NE		
8	dpad_E		
9	dpad_SE		
10	dpad_S		
11	dpad_SW		
12	dpad_W		
13	dpad_NW		
14	left_joy_left		left
15	left_joy_right		right
16	left_joy_up		
17	left_joy_down		
18	right_joy_left	left	
19	right_joy_right	right	
20	right_joy_up	up	up
21	right_joy_down	down	down
22	left_1	mp_left_sip	mp_left_sip
23	left_2	mp_left_puff	mp_left_puff
24	left_3	mp_left_puff_soft	mp_left_puff_soft
25	right_1	mp_right_sip	mp_right_sip
26	right_2	mp_right_puff	mp_right_puff
27	right_3	mp_right_puff_soft	mp_right_puff_soft
28	x	lip	lip
29	circle	mp_center_puff	mp_center_puff
30	square	mp_center_sip	mp_center_sip
31	triangle	mp_right_center_sip	mp_right_center_sip
32	select	right_sip_soft	right_sip_soft
33	ps3	mp_center_sip_soft	mp_center_sip_soft
34	start	mp_right_sip_soft	mp_right_sip_soft
35	start	mp_right_center_sip_soft	mp_right_center_sip_soft
36			
37			
38			
39			
40			

Illustration 26: PS3 Right Joystick Profile

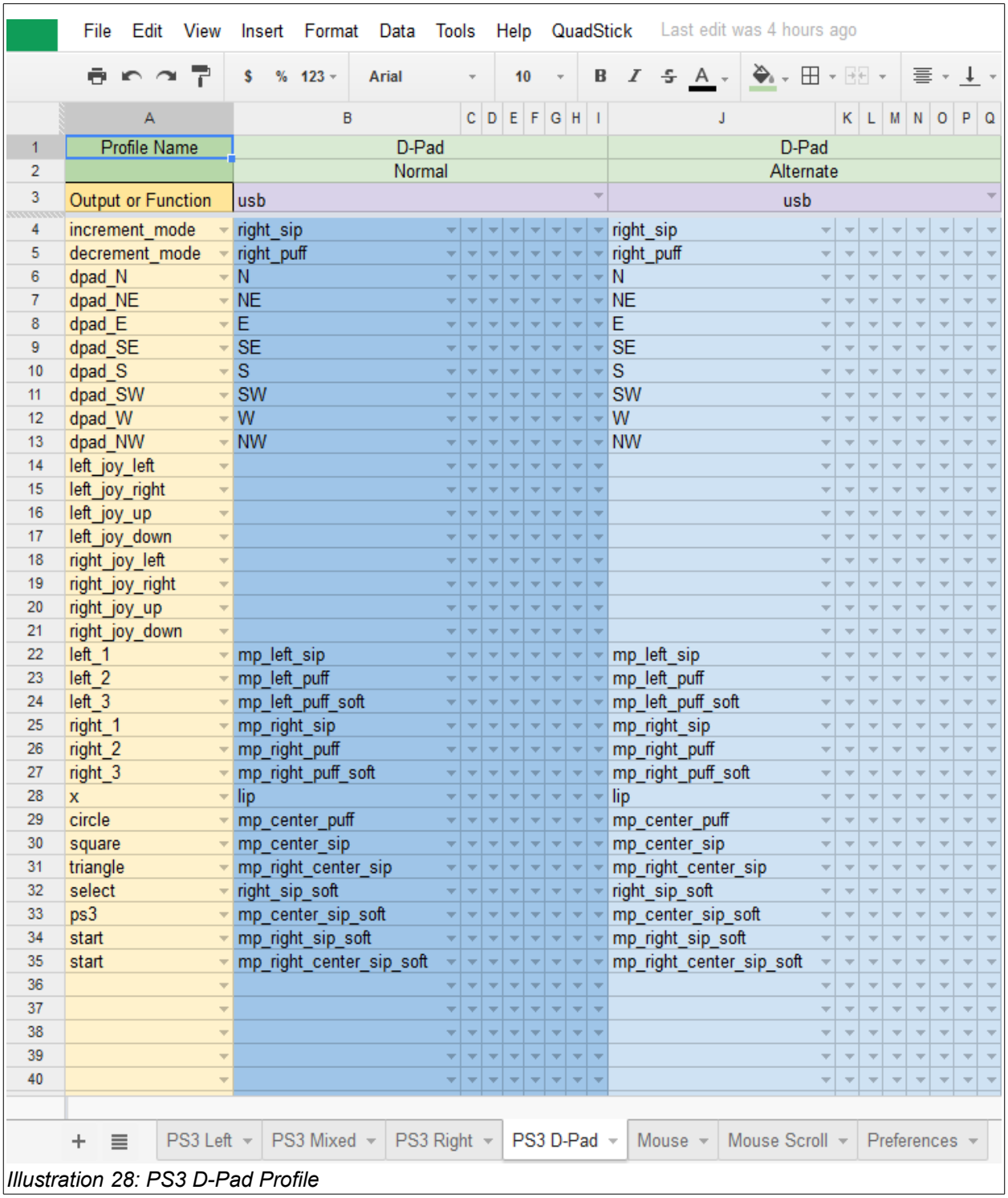
PS3 Mixed Left Movement, Right Steering Joystick Mode



	A	B	J
1	Profile Name	Left joy	Mixed joy
2		Normal	Alternate
3	Output or Function	usb	usb
4	increment_mode	right_sip	right_sip
5	decrement_mode	right_puff	right_puff
6	dpad_N		
7	dpad_NE		
8	dpad_E		
9	dpad_SE		
10	dpad_S		
11	dpad_SW		
12	dpad_W		
13	dpad_NW		
14	left_joy_left		
15	left_joy_right		
16	left_joy_up	up	up
17	left_joy_down	down	down
18	right_joy_left	left	left
19	right_joy_right	right	right
20	right_joy_up		
21	right_joy_down		
22	left_1	mp_left_sip	mp_left_sip
23	left_2	mp_left_puff	mp_left_puff
24	left_3	mp_left_puff_soft	mp_left_puff_soft
25	right_1	mp_right_sip	mp_right_sip
26	right_2	mp_right_puff	mp_right_puff
27	right_3	mp_right_puff_soft	mp_right_puff_soft
28	x	lip	lip
29	circle	mp_center_puff	mp_center_puff
30	square	mp_center_sip	mp_center_sip
31	triangle	mp_right_center_sip	mp_right_center_sip
32	select	right_sip_soft	right_sip_soft
33	ps3	mp_center_sip_soft	mp_center_sip_soft
34	start	mp_right_sip_soft	mp_right_sip_soft
35	start	mp_right_center_sip_soft	mp_right_center_sip_soft
36			
37			
38			
39			
40			

Illustration 27: PS3 Mixed Joystick Profile

PS3 D-Pad Profile



	A	B	J
1	Profile Name	D-Pad	D-Pad
2		Normal	Alternate
3	Output or Function	usb	usb
4	increment_mode	right_sip	right_sip
5	decrement_mode	right_puff	right_puff
6	dpad_N	N	N
7	dpad_NE	NE	NE
8	dpad_E	E	E
9	dpad_SE	SE	SE
10	dpad_S	S	S
11	dpad_SW	SW	SW
12	dpad_W	W	W
13	dpad_NW	NW	NW
14	left_joy_left		
15	left_joy_right		
16	left_joy_up		
17	left_joy_down		
18	right_joy_left		
19	right_joy_right		
20	right_joy_up		
21	right_joy_down		
22	left_1	mp_left_sip	mp_left_sip
23	left_2	mp_left_puff	mp_left_puff
24	left_3	mp_left_puff_soft	mp_left_puff_soft
25	right_1	mp_right_sip	mp_right_sip
26	right_2	mp_right_puff	mp_right_puff
27	right_3	mp_right_puff_soft	mp_right_puff_soft
28	x	lip	lip
29	circle	mp_center_puff	mp_center_puff
30	square	mp_center_sip	mp_center_sip
31	triangle	mp_right_center_sip	mp_right_center_sip
32	select	right_sip_soft	right_sip_soft
33	ps3	mp_center_sip_soft	mp_center_sip_soft
34	start	mp_right_sip_soft	mp_right_sip_soft
35	start	mp_right_center_sip_soft	mp_right_center_sip_soft
36			
37			
38			
39			
40			

Illustration 28: PS3 D-Pad Profile

System Settings Profile

default config

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Comments

Profile Name

	A	B	J
1	Profile Name	System	System
2		Normal	Alternate
3	Output or Function	usb	none
4	increment_mode	push	
5	decrement_mode		push
6	digital_out1_on	left_sip_soft	
7	digital_out1_off	left_puff_soft	
8	digital_out1_toggle		
9	digital_out2_on	right_sip_soft	
10	digital_out2_off	right_puff_soft	
11	digital_out2_toggle		
12	brightness_up	left	
13	brightness_down	right	
14	volume_up	up	
15	volume_down	down	

Mouse | Keyboard | PS3 Right | PS3 Left | PS3 D-Pad | System | Preferences

Illustration 29: System Settings Profile

Changing Profiles

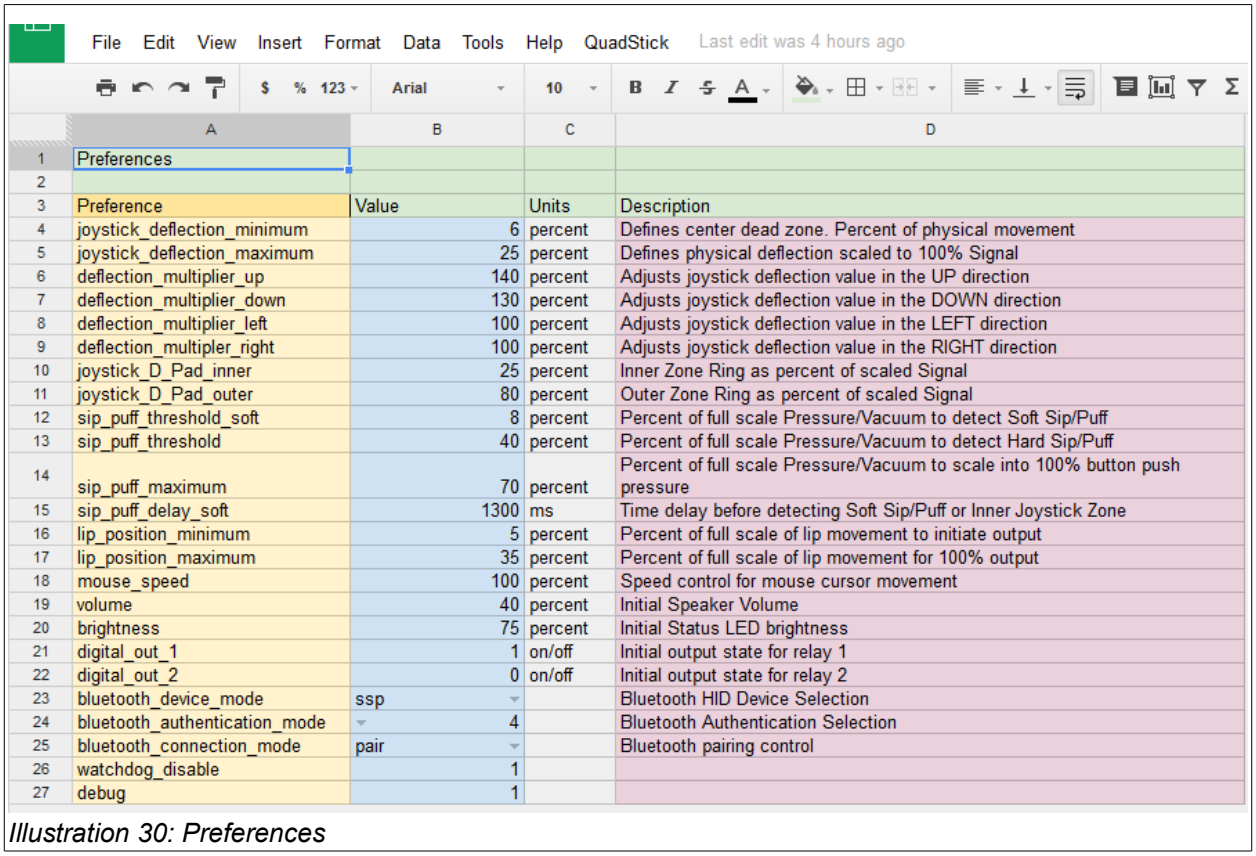
The profiles are numbered starting with 1, in the order their sheets appear in the spreadsheet program. The default method to increment to the next profile is to activate the Right Sip tube. Puffing on the Right tube decrements the mode to the previous profile. The active profile's number is displayed on the status LEDs when the profile changes and after a short delay whenever no inputs are active. The LEDs are numbered one through five, left to right. After mode five, the fifth LED stays on and the pattern starts over from the left until the nineth mode, then both four and five stay on and the pattern repeats. The sum of the LED numbers indicates the mode number up to 15.

Since the transition between modes is controlled within the mode's profile, another input signal can be used instead of the Right Sip/Puff, if desired.

Voice mode commands can switch the QuadStick directly to any desired mode.

Preferences

The Preferences sheet is for settings that control the overall operation of the QuadStick. The sensitivity of the Joystick and Sip/Puff sensors, how long the delay for detecting soft Sip/Puff or inner joystick zones, and how hard of a bite is needed to detect are adjusted here.



	A	B	C	D
1	Preferences			
2				
3	Preference	Value	Units	Description
4	joystick_deflection_minimum	6	percent	Defines center dead zone. Percent of physical movement
5	joystick_deflection_maximum	25	percent	Defines physical deflection scaled to 100% Signal
6	deflection_multiplier_up	140	percent	Adjusts joystick deflection value in the UP direction
7	deflection_multiplier_down	130	percent	Adjusts joystick deflection value in the DOWN direction
8	deflection_multiplier_left	100	percent	Adjusts joystick deflection value in the LEFT direction
9	deflection_multipler_right	100	percent	Adjusts joystick deflection value in the RIGHT direction
10	joystick_D_Pad_inner	25	percent	Inner Zone Ring as percent of scaled Signal
11	joystick_D_Pad_outer	80	percent	Outer Zone Ring as percent of scaled Signal
12	sip_puff_threshold_soft	8	percent	Percent of full scale Pressure/Vacuum to detect Soft Sip/Puff
13	sip_puff_threshold	40	percent	Percent of full scale Pressure/Vacuum to detect Hard Sip/Puff
14	sip_puff_maximum	70	percent	Percent of full scale Pressure/Vacuum to scale into 100% button push pressure
15	sip_puff_delay_soft	1300	ms	Time delay before detecting Soft Sip/Puff or Inner Joystick Zone
16	lip_position_minimum	5	percent	Percent of full scale of lip movement to initiate output
17	lip_position_maximum	35	percent	Percent of full scale of lip movement for 100% output
18	mouse_speed	100	percent	Speed control for mouse cursor movement
19	volume	40	percent	Initial Speaker Volume
20	brightness	75	percent	Initial Status LED brightness
21	digital_out_1	1	on/off	Initial output state for relay 1
22	digital_out_2	0	on/off	Initial output state for relay 2
23	bluetooth_device_mode	ssp		Bluetooth HID Device Selection
24	bluetooth_authentication_mode	4		Bluetooth Authentication Selection
25	bluetooth_connection_mode	pair		Bluetooth pairing control
26	watchdog_disable	1		
27	debug	1		

Illustration 30: Preferences

The joystick_deflection_minimum and _maximum settings are relative to the full mechanical movement of the joystick. They control the overall sensitivity of the joystick movement.

The joystick_D_Pad_inner and _outer settings are relative to the signal calculated as a result of the deflection settings.

Bluetooth

Connection

The Bluetooth communication channel can be used instead of the USB connection for the Mouse and/or Keyboard, plus it can emulate a generic Gamepad (not PS3 specific), and a Joystick, or it can be used as a serial connection for relaying voice commands. It does not support a Flash drive over the Bluetooth, so profile and firmware updates still need to occur through the USB connection.

The Bluetooth module is a Roving Networks RN-42 with the HID firmware. Three parameters that control the setup of the module are adjustable in the Preferences section of the configuration:

- Bluetooth_device_mode (mutually exclusive)
  - keyboard
  - game_pad
  - mouse
  - combo (keyboard & mouse together)
  - joystick
  - ssp (a serial connection used in Voice control applications)
- Bluetooth_authentication_mode
  - 0 Bluetooth version 2.0 NO encryption (open mode)
  - 1 Bluetooth version 2.1 mode
  - 2 Bluetooth version 2.1 Secure Simple Pairing (SSP),
  - 4 Bluetooth version 2.0 PIN code authentication
- Bluetooth_connection_mode
  - slave (needs to be reconnected to host after each restart)
  - master
  - trigger
  - auto
  - dtr
  - any
  - pair (will automatically reconnect to host)

Platform Notes

Each host type below has different preferences for these three settings

Android

Illustration 31: Nexus 7

Used with a Google Nexus 7 pad. Bluetooth Device mode=Mouse, Keyboard, Combo or Gamepad, Authentication Mode= 1, Connection Mode=Pair.

The QuadStick can also be used with a USB OTG cable and get power from the Android host instead of using Bluetooth and being powered by another source. The catch is, the Android device will not accept external power while in this mode (unless Rooted and running special software), so both the Android device and the QuadStick will get their power from the device's battery. It's useful for portable situations, but for a more permanent setup, powering both and connecting via Bluetooth works better.

PS3

PC

Iphone

Not officially supported.

Used successfully on a jailbroken iPhone 3GS running BTStack Mouse version1.6-4, Bluetooth device mode = Mouse, Authentication mode=4 and Connection mode=pair.

Using the standard Apple bluetooth stack is not currently supported due to the high cost of obtaining a license from Apple. If there is enough demand to use the QuadStick with a non-jailbroken iOS host, the Bluetooth module used in the QuadStick is available in an iOS compatible version.

Configuration Notes

Selecting Bluetooth in a Profile

Available Outputs for Emulated Devices

PS3 Usage and Configuration

Home Button

The PS3 Console requires the Home Button (PS3) be activated to recognize the Gamepad portion of the QuadStick. The Mouse, Keyboard and Flash should be recognized when plugged in.

Downloading Configuration Files with Web Browser

Let's face it: The browser in the PS3 is not very good. It is not usable with Google Docs Spreadsheets, but it will download CSV files and put them into the flash drive on the QuadStick. The Save As CSV command, used from a PC, can put a copy of the CSV file in the Google Drive folder, which can then be downloaded using the PS3. This is where sharing the configuration spreadsheet with another person comes in handy.

Keyboard Shortcuts and Other Tips

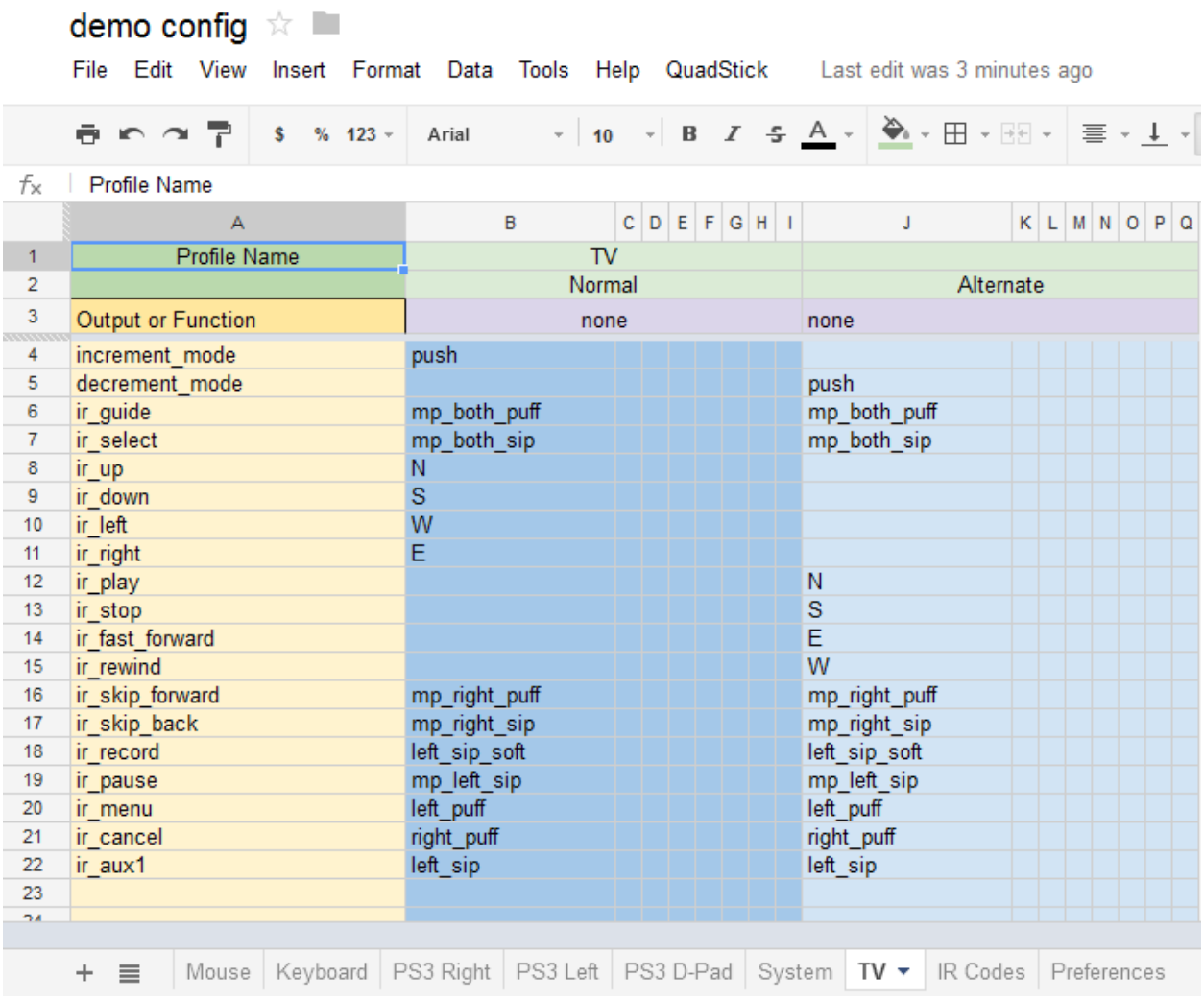
Copy “config.csv” file into QuadStick Flash

Setup scheduled Task to copy from Google Drive

Example Configurations

Infrared Remote Control

Setting up the Infrared transmitter is a two step process: The desired commands are placed into a Profile sheet in the configuration spreadsheet, then the Philips Pronto Hex codes must be obtained for the A/V equipment and copied into a sheet named “IR Codes” that the QuadStick uses to drive the IR LED when one of the commands is triggered. The following example is programmed for a Dish VIP-622 receiver.



demo config

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Profile Name

	A	B	J
1	Profile Name	TV	
2		Normal	Alternate
3	Output or Function	none	none
4	increment_mode	push	
5	decrement_mode		push
6	ir_guide	mp_both_puff	mp_both_puff
7	ir_select	mp_both_sip	mp_both_sip
8	ir_up	N	
9	ir_down	S	
10	ir_left	W	
11	ir_right	E	
12	ir_play		N
13	ir_stop		S
14	ir_fast_forward		E
15	ir_rewind		W
16	ir_skip_forward	mp_right_puff	mp_right_puff
17	ir_skip_back	mp_right_sip	mp_right_sip
18	ir_record	left_sip_soft	left_sip_soft
19	ir_pause	mp_left_sip	mp_left_sip
20	ir_menu	left_puff	left_puff
21	ir_cancel	right_puff	right_puff
22	ir_aux1	left_sip	left_sip
23			

Mouse Keyboard PS3 Right PS3 Left PS3 D-Pad System TV IR Codes Preferences

Next the Philips Pronto Hex codes are entered into an IR Codes sheet for each command used in the profile. Obtaining the proper codes can be a chore. Hopefully a library of command codes for various devices will be generated by the users. The QuadStick has an IR Receiver for learning codes, but the software has not been implemented:

Infrared	Phillips Pronto Infrared HEX codes for Dish VIP-622
	dvr_622_dss_receiver_dvr.html
Command Name	Hex Code
ir_guide	0000 0048 0001 0011 0017 0166 0018 00A3 0017 0060 0017 00A4 0017 0060 0017 00A4 0017 00A3 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0018 00A3 0017 00A4 0017 00A3 0017 00A3 0017 00A4 0017 00A4 0017 0166
ir_select	0000 0048 0001 0011 0017 0166 0018 00A3 0017 0060 0017 00A4 0017 00A3 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A4 0017 00A4 0017 00A3 0018 00A3 0017 0166
ir_up	0000 004B 0001 0011 0016 0155 0018 009C 0017 005D 0017 005C 0017 009D 0017 005C 0017 009D 0017 009C 0018 009C 0017 009D 0017 009D 0017 009C 0018 009C 0017 009D 0017 009C 0018 009C 0017 009D 0017 0155
ir_down	0000 0048 0001 0011 0017 0166 0018 00A3 0016 0060 0017 0060 0017 0061 0017 0061 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A4 0017 00A4 0017 00A3 0018 00A3 0017 00A4 0017 00A3 0018 00A3 0017 0166
ir_left	0000 0048 0001 0011 0017 0166 0018 00A3 0017 0061 0017 0061 0018 0060 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A4 0017 00A3 0017 00A3 0017 00A3 0017 00A4 0017 00A3 0018 00A3 0017 00A3 0017 0166
ir_right	0000 0048 0001 0011 0017 0166 0018 00A3 0017 0060 0017 0061 0017 00A4 0017 00A4 0017 00A3 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A4 0017 00A4 0017 00A3 0018 00A3 0017 00A4 0017 00A3 0018 0166
ir_play	0000 0048 0000 0011 0017 0166 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 0060 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3
ir_stop	0000 0048 0000 0011 0017 0166 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3
ir_fast_forward	0000 0049 0000 0011 0017 0160 0017 0061 0017 0061 0017 00A0 0017 00A0 0017 0061 0017 00A0 0017 00A0 0017 00A0 0017 00A0 0017 00A0 0017 00A0 0017 0061 0017 00A0 0017 00A0 0017 00A0 0017 00A0
ir_rewind	0000 0048 0000 0011 0017 0166 0017 0060 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3
ir_skip_forward	0000 0048 0000 0011 0017 0166 0017 0060 0017 0060 0017 00A3 0017 0060 0017 0060 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3
ir_skip_back	0000 0048 0000 0011 0017 0166 0017 0060 0017 0060 0017 00A3 0017 0060 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3
ir_record	0000 0048 0000 0011 0017 0166 0017 00A3 0017 0060 0017 0060 0017 0060 0017 0060 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3
ir_pause	0000 0048 0000 0011 0017 0166 0017 0060 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3 0017 00A3
ir_menu	0000 0048 0001 0011 0017 0166 0018 00A3 0017 00A4 0017 0060 0017 00A3 0017 0061 0017 0060 0017 00A3 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0018 00A3 0017 00A4 0017 00A3 0017 00A3 0017 00A4 0017 0166
ir_cancel	0000 0048 0001 0011 0017 0166 0018 00A3 0017 0061 0017 00A4 0017 00A3 0017 0060 0017 00A3 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0018 00A3 0017 00A4 0017 00A3 0018 00A3 0017 00A4 0017 00A4 0017 0166
ir_aux1	0000 0048 0001 0011 0017 0166 0018 00A3 0017 0060 0017 0061 0018 00A3 0017 0060 0017 0060 0017 00A4 0017 00A4 0017 00A3 0018 00A3 0017 00A4 0017 00A3 0018 00A3 0017 00A3 0017 00A3 0017 00A3 0018 0166

Tribes Configuration

Tribes: Ascend is an online game for PC's. It uses a combination of keyboard commands and the mouse.

We mapped this game out with the Joystick controlling the Mouse movement (which aims the weapon), and the Sip/Puff sensors as follows:

Fire	Left Mouse Button	mp_both_sip
Jetpack	Right Mouse Button	bite
Move Forward	W	mp_both_puff
Move Left	A	mp_left_sip
Move Back	S	mp_both_sip_soft
Move Right	D	mp_right_sip
Ski	Space Bar	mp_left_puff
Zoom	Left Shift	mp_both_puff_soft
Weapon	Q	left_sip
Melee	E	mp_right_puff
Belt	F	right_sip
Use	G	right_puff
Drop Flag	Z	left_puff
Camera	X	right_sip_soft
Scoreboard	Escape	left_sip_soft

Tribes Demo Config

File Edit View Insert Format Data Tools Help QuadStick All changes saved in Drive

Profile Name

	A	B	J
1	Profile Name	Right joy	Mixed joy
2		Normal	Alternate
3	Output or Function	usb	usb
4	increment_mode	push	
5	decrement_mode		push
6	mouse_left	left	left
7	mouse_right	right	right
8	mouse_up	up	up
9	mouse_down	down	down
10	kb_w	mp_both_puff	mp_both_puff
11	kb_a	mp_left_sip	mp_left_sip
12	kb_d	mp_right_sip	mp_right_sip
13	kb_s	mp_both_sip_soft	mp_both_sip_soft
14	mouse_left_button	mp_both_sip	mp_both_sip
15	kb_space	mp_left_puff	mp_left_puff
16	mouse_right_button	bite	bite
17	kb_left_shift	mp_both_puff_soft	mp_both_puff_soft
18	kb_q	left_sip	left_sip
19	kb_e	mp_right_puff	mp_right_puff
20	kb_f	right_sip	right_sip
21	kb_g	right_puff	right_puff
22	kb_z	left_puff	left_puff
23	kb_x	right_sip_soft	right_sip_soft
24	kb_escape	left_sip_soft	left_sip_soft
25			

Mouse Keyboard Tribes System Preferences

Illustration 32: Tribes WASD Keyboard Profile

Physical maintenance

Cleaning Mouthpiece

The mouthpiece can be removed and cleaned with soap and water, but is not dishwasher safe. Any debris blocking the air holes can be pushed out from the barbed fitting end with a small wire. It can be sterilized with rubbing alcohol.

Make sure the airways are dry before reattaching the mouthpiece to the joystick shaft.